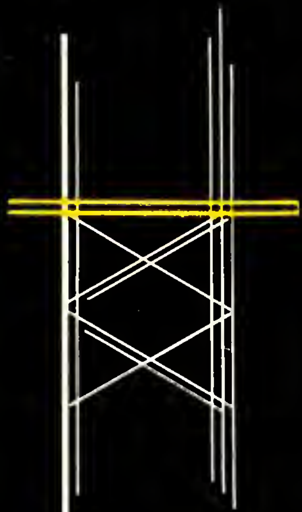
MODERN MASONARY

NATIONAL ACADEMY OF SCIENCES



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NATURAL STONE AND CLAY PRODUCTS

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BUILDING RESEARCH INSTITUTE OF THE NATIONAL ACADEMY OF SCIENC

modern masonry

NATURAL STONE AND CLAY PRODUCTS

The edited papers and discussions of a research correlation conference on natural stone and clay products conducted by the Building Research Institute in Washington, D. C., on September 19 and 20, 1956.

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Contents

Welcome to Conference

William H. Scheick
Executive Director,
Building Research Institute
National Academy of Sciences—
National Research Council

I AM here to welcome you to the Conference on Modern Masonry on behalf of our President, Mr. Edmund Claxton, who is temporarily absent in Europe, and the entire Building Research Institute.

The program we offer today will, we believe, equal in excellence any we have put together. We take great pride in the fact that the noted men we have as speakers on this program are willing to take the time to prepare papers and come here and speak. This splendid cooperation makes it possible for the Building Research Institute to make the contribution to the advance of building science that is our reason for being.

I would like to note that this Conference on Modern Masonry does not cover all types of masonry products. We limited the subject on purpose. Stone and clay products—the subject we have chosen for our discussion—are the ones

most closely related to each other. They are therefore a proper subject by themselves for the kind of research correlation conference we are conducting.

Our conference is under the general supervision of a chairman who is highly qualified by his broad knowledge of building and his knowledge of the conference subjects. He is Mr. C. E. Silling, head of the architectural firm of C. E. Silling and Associates of Charleston, West Virginia.

Mr. Silling began his work as office boy in the firm he is now heading, following his graduation from the Carnegie Institute of Technology with a Bachelor of Arts in Architecture. He is a Medallist, Beaux Arts Institute of Designs and a winner of the New York Municipal Arts Society Prize. A Fellow of the American Institute of Architects, he served as past president and former secretary-treasurer of the Virginia chapter and as a past director of the National Board of the AIA. Mr. Silling is considered one of the most ardent supporters of modular coordination and an eloquent speaker on architectural subjects.

Introduction to Conference

C. E. Silling

C. E. Silling and Associates, Charleston, W. Va.

GENTLEMEN, into this building come the great and small of American business. I am sure that you are here today on business. Some of our finest idealists are businessmen; some of our greatest poets are businessmen. I do not mean that they are writing poetry or talking ideals. They are expressing their ideals in brick and mortar.

The businessman who puts up a beautiful building must have something of the poet in his soul. The businessman who erects a model factory and thus sets the pace for others to follow must have something of the idealist in his makeup. The businessman who pioneers with a new labor-saving device and teaches his customers how to use it must have the spirit of the teacher. Some of the finest, the most wholesome, the most beautiful expressions of modern times are inspired by businessmen as a matter of business.

I am told that many years ago our architectural society in New York sent out notices stating that a panel of architects would speak at its next dinner meeting with its subject title, "The Greatest Single Need of the Architectural Profession."

The flood of reservations was amazing; the buzz of anticipation great, indeed. At the appointed hour the panel of architects arose in dignity and said, "The greatest single need of

the architectural profession is a first-class crack filler," sat down, the meeting was ended and there was unanimous agreement.

Some months ago I attended a meeting of the Research Institute here in Washington on metal panel curtain wall construction. The learned gentlemen discussed infiltration, insulation, condensation, thermal induction and finally came around to deduction. If I understood the implications correctly, they join with the architects in the search for a first-class crack filler.

There was one item of profit for the masonry people that came out of that meeting and the variety of metal panel publicity that preceded and followed it. The metal panel men have scared the daylights out of you people and you are here to search yourselves. It is about time. You were the first on the scene and you have had the advantage of antiquity even before recorded time. Also, you have had the advantage of modular measure.

In seeking to gain all, some of you have to lose your own recalcitrance. Post-war production and consumption has developed into a kind of industrial and economic revolution; new products, new processes, new materials, mechanization, automation, the thrust that comes from the electronic brain, carbide-type cutting tools, new high heat, heavy stress metals, chemistry and physics that bring artificial fibers and amazing plastics, not to mention atomic energy, and unbelievably fast transportation. These developments multiply into the many changes we witness. For example, the farmer has become a mechanized chemist and part-time economist interested in a variety of things. Somehow all these separate elements must be studied in their social impact on the community as a whole. In this welter of change and inflation the problem of providing facilities the client can pay for seems to be one of the main pressures behind the invention of new products or new ways of using old products.

Architects, engineers, contractors, materials manufacturers, and suppliers presently enjoy the intimacies of a shot-gun wedding. They study the technologies primarily in order to survive. It is this climate that encourages us to meet with the Building Research Institute today. The Building Research Institute's conferences are always objective and try to do three things: (1) Tell what is new; (2) analyze existing problems; and (3) suggest things that need to be done, including research.

The speakers on this panel are divided into two groups. One group is made up primarily of technical men and research men from the masonry industry itself. We can expect them to be prejudiced in favor of masonry. The other group is made up of outstanding architects, engineers and building authorities, both profane and bureaucratic, or more politely, from industry and government. They have not been selected because they are dedicated to the use of masonry, but because they have had broad experience with it, and we know they will be objective and forthright in their discussions.

To introduce your first session chairman I will now read from the closing verse on art by Huberty Junius, whoever he is:

"The devil simply sat and grinned
As he always has since the first man sinned;

"For he knows he will always have a part
When three men sit and talk of art."

John Knox Shear is a provocative devil, gracious in an insidious kind of way, incisive and informative. He is also Editor-in-Chief of the Architectural Record; a competent architect in his own right; a good fellow, and my good friend. He will preside and introduce the three panelists who will sit with you and talk of architectural design.

PART ONE

Architectural Design

PRESIDING CHAIRMAN:

John Knox Shear
Editor-in-Chief,
Architectural Record

MR. SHEAR: This is the conference I have been awaiting for a long time, ever since I first heard that it was being planned. I am sure most of you feel as I do. We have a lot to learn here.

Mr. Richard M. Bennett, our first speaker, is a practicing architect of distinction and a member of the firm of Loebl, Schlossman & Bennett of Chicago. He has taught and written on architecture. Currently he is representing architecture on a committee advising the State Department on its foreign building operations. He is a Fellow and former member of the Board of Directors of the American Institute of Architects and has received much praise and several awards for his distinguished work in residential, commercial, religious, and public buildings.

The Aesthetic Demands of Contemporary Architecture Upon Masonry

Richard M. Bennett
Loebl, Schlossman & Bennett,
Chicago, Ill

My first introduction to masonry construction goes back a long, long time in my memory. As a very little boy, I watched my grandfather build a brick garage. This was in an age and place where people still had barns and stables. "Garage" was a new word in our language then. Our garage was quite modern, too—it had a flat roof, a poured concrete floor, and an asymmetric elevation and plan to accommodate on one side a work bench for almost continuous mechanical repairs and maintenance. I believe the neighbors thought this unfamiliar structure extremely ugly. My grandmother had made my grandfather retire some years before, but this old man never really quit—he just helped people build things for joy instead of money. He had learned building as an apprentice, nearly a hundred years ago, and he learned to love a piece of stone, well laid brick, a straight grained piece of wood, and it is probably his influence which is behind my being here today.

And, I am glad to be here with you to carry on, if I can, his attitude that a brick is more than a brick, a stone more than a stone, a building more than just a structure when man builds and selects with the objectives of beauty and a sense of rightness which transcend what we arbitrarily call utilitarian concerns. This is what the title of my assignment here really means when it says "The Aesthetic Demands of Contemporary Architecture upon Masonry."

That word *Aesthetics* is a license that allows for some of the loosest talking and writing men do, and it is only the realization that I cannot cover the ground thoroughly anyhow that allows me to feel no shame in my own simplified, arbitrary approach.

The dictionary is a good starting point. The root of our word aesthetics is "esthesia" which means the *ability to feel*. The word aesthetic itself means "sensitive to art and beauty." It connotes discrimination, judgment—above all, the rejection of those things which do not measure up to certain purely personal standards. Somehow, this accepted definition of the word "aesthetic" doesn't seem to me to have enough scope for a survey of today's use, and tomorrow's role, for a great historic building material.

So, let us get back to the root of things and agree that what we are really after is what a designer of a building is interested in when he seeks to make a building beautiful; or, in other words, make those who see his buildings have feelings of beauty. The designer is (and perhaps we are coining a word) an *aesthesiast*—one who makes people have feelings—just the opposite of an anesthetist. Whether the designer's endeavors are judged beautiful often varies with time and place. And this is the most important point: *different* designers see their goals in *different* ways; do so with great conviction; and are supported by able critics and aestheticians in their differences. The inevitable result is that today's obviously beautiful building is sometimes tomorrow's awkward relic, and sometimes today's unnoticed solution is tomorrow's beloved heirloom.

Today the architectural scene is, as always, rich with two broad trends—classic and romantic. Always the classic is cool, impersonal, disciplined and balanced. Miës van de Rohe is this generation's great classicist—classicist *and progressive*. For it must always be remembered that his work is original, but within a framework of greatness, for classicism does not mean sterility. For this audience, his insistence on nothing less than perfect craftsmanship when it comes to masonry, should not be news when you remember his first training was as a stonemason. In the City of Chicago, running bond, seven courses of bricks lengthways and the next end side to, is almost standard. It was almost startling when Miës used meticulous Flemish bond in his first buildings at Illinois Institute of Technology. People had dismissed, even forgotten, the more complicated brick textures. His reintroduction of increased bonding was doubly interesting since his bricks were used, usually, only in curtain walls. The reason, of course, is that in contrast to the running bond the more over-all, uniform pattern made a texture that stayed where it was put—within his usual frame of steel.

While Miës' preoccupation with the exploitation of steel and glass comes first to mind, it must never be forgotten that he is really concerned with fine, meticulous detailing, and the proper use of materials. Brick, in his vocabulary, takes a proper place with all fine materials, such as marble, bronze, wood, aluminum. A most dominant figure in the influence of contemporary architecture by example, as well as a teacher, the trend established by Miës and his group creates a demand for bricks of greater uniformity and precision, both for size as well as for color and texture.

It is significant that his students' early design exercises are based on the brick as a module—and their first houses are designed so that the length of other materials is determined by a multiple of existing brick masonry units.

In dramatic contrast to Miës, and in many ways standing all alone—Frank Lloyd Wright is, without a doubt, the arch-romantic of our age. Throughout his long life, he has been fascinated with expanding the possibilities of masonry construction. It is hard to think of

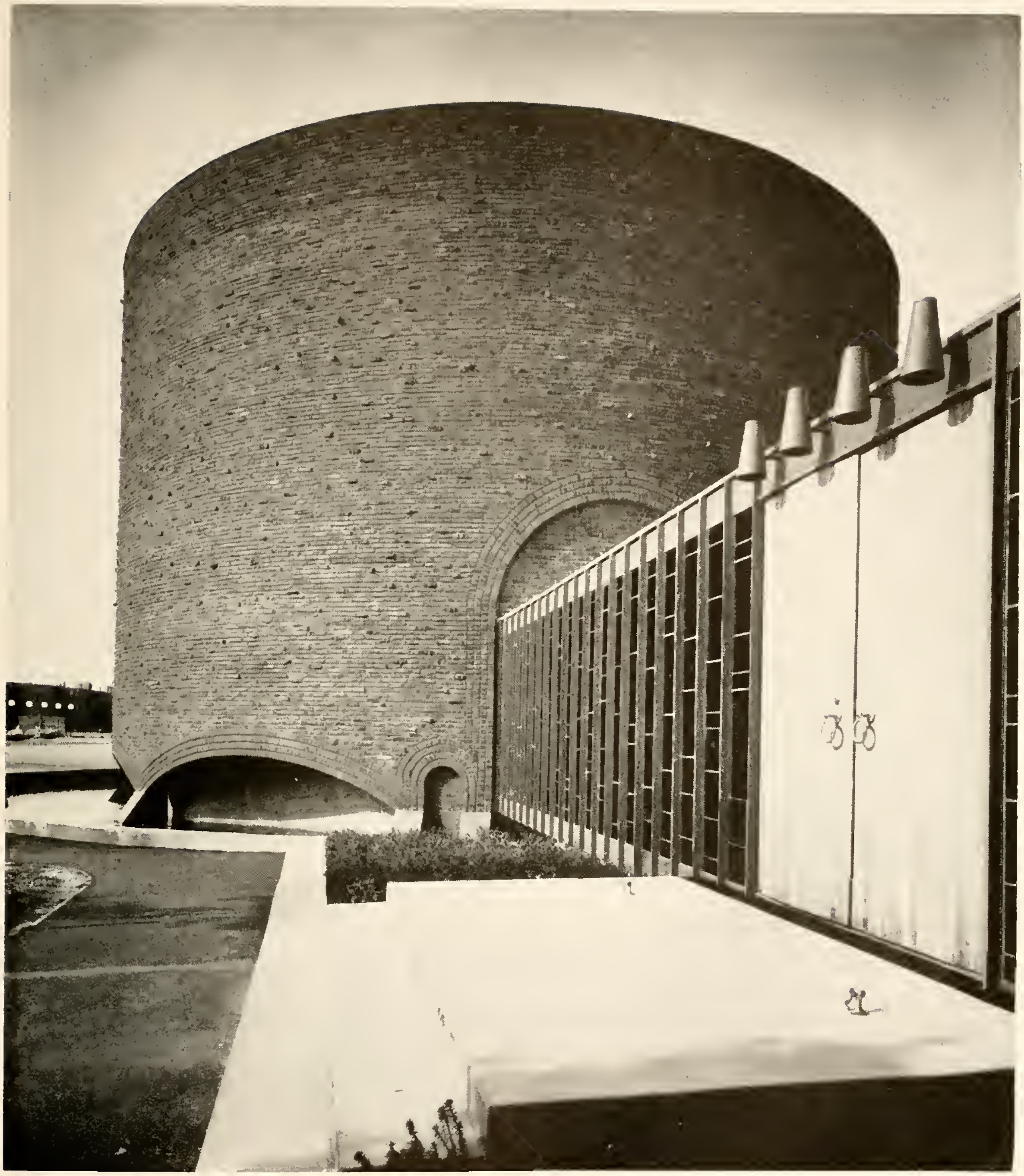


Photo: Ezra Stoller

CHAPEL, MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Eero Saarinen, architect

anyone who has done more in the way of experimenting with prefabricated, precast units, both as structural components and as breathtaking essays in applied pattern and texture. He, of course, has many followers who carry on these interests. If we try to discover the principle underlying the handling of masonry, as shown in Wright-influenced work, we'd find, as he puts it, an interest in the "nature of the material" as a *total* possibility. With him, masonry is made primarily to work—to hold things up. Study of his plans shows that in his greatest work, masonry is disposed in the building so that one can feel the compressive forces concentrated in the solid masonry masses, using and expressing other materials to take the tensile and bending forces of the building.

The romanticist is more apt to be interested in the individual, unique architectural solution —and the individual brick—underburned, overburned, oversized, and undersized. All architects, however, I believe, will become more and more interested in the complete wall, one which uses the same material inside and out. Concern with the integrity of the way—the reality behind the surface appearance is a real aesthetic matter and very important in the development of new masonry forms. It is beyond the scope of this paper to discuss the merits of modular units, to examine composite materials designed to be light, to have greater insulating value, to be of sizes more easily placed, and the like. The exciting possibilities of masonry elements for sun shades, grilles and other functional forms; color glazes; all await further exploitation by designers. All these present aesthetic problems but their solution lies within the same principles that hold for present masonry uses.

Currently, the trend in architecture seems to lean mostly toward the classic Miës, but I believe that the inevitable swing of the pendulum toward the freer, romantic trend is not far away. LeCorbusier's latest church seems to defy all his writings of the last thirty years in its heavily over-emphasized stuccoed masonry walls, bizarre roof and emphatically arbitrary window placement. The straight lines of steel and economically formed concrete of his theories are forgotten in his obvious delight in masses and shapes that can most logically be discovered in masonry. Such deviation toward a highly individual solution by one known for his previous emphasis on a "machine" age cannot help but exert a strong romantic influence on many young men.

Two well-publicized projects—Philip Johnson's own house and Saarinen's M.I.T. Chapel and Auditorium—are most interesting because they both demonstrate the two-sided interests of so many of today's architects. The precise steel-and-glass main structure of Johnson's home is contrasted with his brick, solid-walled neighboring guest house. In similar vein, Saarinen's eggshell-thick plastic-covered concrete dome with walls of aluminum and glass is balanced against a cylinder of brick which encloses one of the most inspiring chapels of our time. Much of the success of the chapel, as well as some of the interior brickwork beneath the auditorium dome, results from the search for and selection of bricks with inherent individuality and variety in size and color, and a mortar color that blends the diversity of the units into a unity of the whole wall to achieve a satisfaction made more thrilling because of its apparently artless subtlety.

The architect as aesthesiast—maker of people to feel—has become the concern of Walter Gropius of late. His early writings were important for their pioneer expression of the possibilities and inevitableness of machine production in building and its resulting uncompromising precision. Writing of his recent trip to Japan, one senses a greater affection perhaps for natural material, and certainly brick is a natural material and a machine-age product, too. This

seems to suggest a coming greater interest in the individual, unique manifestation of variety, warmth, and richness of depth associated with natural masonry.

Not long ago, it was common to hear so-called advanced architects and critics predict the end of out-moded heavy masonry. Some of their criticisms were correct, and in steel and concrete frame construction the masonry curtain wall is being used less and less. And this is reasonable since the nature of the material is inappropriate. But brick *is* appropriate, and, as far as one can see ahead, will always be appropriate in many places. As contemporary design develops, it will be strange if masonry does not become even more loved as we learn where it is *most* appropriate. The greatest mistake of our time seems to me to be the search for the "*all*" solution—whether it is all glass, all aluminum, all steel, or even *all* brick. A building can be compared to biological construction; and, who would think of an only all-gristle, an only all-fat, or only all-bone girl?

What does this short and over-simplified little survey suggest? It seems to me the most important point is that different architects can use the same unit with different objectives. Let me illustrate by comparing architecture with another art—the stage. The great Radio City Music Hall lines up scores of girls, picked for similarity of size and conformation, made more alike by identical clothes and wigs, all kicking, turning, and bending in breathtaking precision. This is certainly a kind of beauty—the beauty of repeated precision. It is beauty consistent with our mass production world. It is a reassuring kind of beauty when we identify ourselves, too, as kinds of similar cogs in this terrifying complicated civilization. But, let us take the chorus of a musical comedy where the precision may not be so consistent but plot, choreography, and a more intimate-sized theatre permit looking at separate members of the chorus from time to time. Unit becomes less uniform—and we cannot help but see this introduction of variety and contrast achieves another kind of beauty. Then, take Jackie Gleason's successful TV presentation—designed first to show the June Taylor girls' astonishingly precise, disciplined dancing from above, front, side, and back—and, again we have a precise beauty. But, no small success of his program is the introduction of one pretty girl at a time to announce one word or phrase, and at the end to have the entire cast appear, one by one, from behind the curtain. And, finally, of course, the stage uses people in another way—in plays. In a play, the individuals are unified in an art form in which ideas and conflicts form the mortar that blends the simulated inner characters of the performers into a beauty beyond surface appearance.

And so it is with masonry. It is susceptible of being handled in many, many different ways, from a mechanically precise wall enclosing a factory, to mosaics, perhaps abstract, symbolic or even representational—at any rate, establishing a meaning that transcends the appearance of the material of which it is composed because the relation of each part has been established by the designer in an order beyond utility.

Beside the designer, there is another important person involved in masonry construction, and that is the craftsman. When one hears of the disappearance of the craftsman, remember that, as designers demand precision and absolute uniform bricklaying, they are turning a man into a machine. As men work in an area in which they can exercise less and less choice, the result shows less and less personality and pride. Some of you may recall that early automobile bodies were decorated with hand-painted, colored stripes. The lack of carriage painters led to a search for a cheaper solution. I have been told that Scotch tape was invented as an aid to this work. At any rate, when Scotch tape or decalcomanias took over,

the stripes disappeared. Similarly, at the time of the Civil War, ladies' dresses revelled in ruffles, but when the sewing machine made ruffles economically available to almost *everyone*, ruffles, like auto stripes, were no longer desirable. Now, I am not suggesting that when that bricklaying machine is perfected, we will give up bricks. What I am saying is this—from time to time bricklayers should be encouraged with jobs like the brickwork of Saarinen's M.I.T. work; and, perhaps, the architect-designer should find a way to let artists and craftsmen, as long as there still are some, have a chance to express *themselves* in a wall.

How long we will have a chance to do such things is questionable. I asked Henry Shepley of Coolidge, Shepley, Bulfinch & Abbott, about the beautiful brick walls one finds in New England—some still being built by his firm at Harvard. They still take brick very, very seriously as an art form and he told me there is only one kiln left in this country that makes hickory-burned brick which has the color and variety underlying those perhaps sentimental, yet undeniably beautiful, Cambridge walls. I do not know what the rest of the industry feels about such production. But, since orders are booked a year in advance, there still must be quite a market for the "old way." We can certainly hope such production never dies entirely out, even though the major trend can never reverse itself far enough to make this a competitive type of market.

If I emphasize some of the qualities of masonry that are a little out of fashion, it is because I think they will come back. Not exactly as they were, but perhaps in essence. The future is, in the main, inevitably bound up with machine production, modular integration, impersonal craftsmanship. This direction is initiated by economic forces more than by aesthetic objectives. It is only when the designer wishes to express the feeling of the machine age that machine age products become *aesthetic* units. More and more designers are gladly accepting mechanical results as the expression of our time—still only the *Early* Machine Age. Machines are what we make them—we can control masonry construction so that even some of the unique qualities now associated only with old, hand-fashioned masonry units should not, and need not, be lost.

As we press forward with new ideas, sound answers to economic necessities, exploit exciting new possibilities, let us not entirely forget certain old beauties—for, as someone has said, and I wish I knew who the wise man was—"He who does not know history will be condemned to repeat it."

Even as Miës re-established Flemish bond in a steel frame and Eero Saarinen reaffirmed the incomparable beauty of the natural color variety in a brick wall under a daring concrete dome, we can expect still more new discoveries, and re-discoveries, in the richness of man's inexhaustibly great building material—masonry.

Photo: Ezra Stoller

JEWISH CHAPEL, INTERFAITH CENTER, BRANDEIS UNIVERSITY, WALTHAM, MASS.
Harrison & Abramovitz, architects

Colors and Textures in Masonry

Joseph P. Moore
Moore & Co., Inc.,
Stamford, Conn.

MR. SHEAR: *Our second speaker of this session is Mr. Joseph P. Moore. He has, I think, come a long way around. He has graduate degrees from Catholic University of America and from Columbia University in Fine Arts and Archeology. Until 1945 he taught fine arts and archeology in colleges. Since then he has been an advertising and public relations executive.*

He has been particularly interested in an area close to your hearts, marble and natural stone.

IT MIGHT be noted at the outset that a great deal of color is being used in architecture today—and some texture. We can even agree that color is used with a proper recognition of its psychological importance. But we must distinguish clearly between colored architecture and the use of color in architecture. We must also distinguish between texture in materials and texture through materials.

It would seem to me that we may have forgotten how to relate our architecture to ourselves in point of scale. Giant masses of color or texture which may help produce a handsome rendering of a building, or which may afford some pleasure when seen from miles away, may have no effectiveness whatever when seen from the immediate area surrounding the building. The kind of color in design or texture in design

which does not produce any immediate sensory response does not satisfy our needs in viewing the building and may have no purpose whatever except in selling the building.

The problem is not one of building size but it is one of scale in its elements. Too many of our buildings today satisfy only our desire to own the biggest or the greatest. They do not satisfy our need for the finest or the most beautiful. So, even the great romanticist among us proposes a building 510 stories high.

Of course, you will recognize immediately that we are rapidly approaching the problem of craftsmen and craftsmanship in architecture. There was a time when the architect himself was a craftsman. Later, he was forced to hire craftsmen as associates, but because of a complete professional training, he was still able to understand them and was properly sympathetic with them. Later still—and until today—although the architect may have an instinct for craftsmanship, and all of our better architects do, his time and his energies have been so absorbed by the mechanical requirements of architecture that he has been forced to disassociate himself from these early alliances.

Compounding the problem is the faceless client, the corporation or group which thinks of building only as investment and judges the value of a piece of architecture by its ability to balance a ledger sheet.

If there is to be a proper integration between architecture and the sister arts and a use of such elementary properties as color and texture, the architect must recognize the need for craftsmanship in all its aspects, and assist in its development. Herbert Hannum assumes this when he writes: "It is the specific responsibility and need of architecture at this point to bring the craftsman back into building—to work with him *to find fresh, creative answers to the use of present materials,* to find fresh combinations of new materials for the best expression of a given architectural space. The more resourceful the craftsman is in dealing with each element, the greater the visual flexibility of the architectural space. The craftsmen and the architects must experiment for fresh solutions to the architectural needs and the materials of our time—but they must experiment together. New crafts and new techniques, new designs, and new architecture may well result. The possibilities are limitless."

This need is strong, not only because it can be determined through professional critical argument, but because the layman cries out for it—though too often merely as a voice without a language.

If I may be permitted an analogy, I should like to call on a current trend in interior decoration and design on the premise that there is one place that the man in the street finds direct outlet for his ideas, immediate expression of *his* conception of how things ought to be.

In the nineteen-thirties—and perhaps earlier—the trend to "modern" furniture was—if not born—nourished. Furniture manufacturers, experimenting with new techniques of production, putting to use the intricate machinery available to them, examining new materials and new design possibilities, probed the market with sleek creations. Three-dimensional ornamentation was clutter; the most obscene word in the language of design was "bric-a-brac;" decoration, where it was allowed to creep in, was confined to new lacquers, inlaid patterns afforded by paper-thin veneers, and appliquéd metals.

Basic designs have changed little in the past quarter century in spite of the efforts of one of our really great architects to relieve the tedium—a relief which Mr. Shear noted recently has resulted in "some of the world's most frightful furniture." Lines are still simple, unadorned, severe. Ornamentation has disappeared. In its place we have the use of richer,

grainier woods, brass drawer pulls, and other accent features. What is the result? How has the man in the street rebelled against this severity which has been foisted upon him? I would be willing to wager that a survey among the men in this room would indicate that more than 50 per cent of the wives represented here have a recently-acquired interest in antiques.

The market in antiques is booming and has been for some years. Antique stores dot the land; we now have annual antique shows.

Well, what does it all mean? Simply this: modern furniture, which has become all design, all structure, needs something to relieve its nakedness. It is a part of each of us that a plain surface cries out for something to be put on it: an apothecary jar made into a lamp or used as a vase; philodendron leaves hanging from a shelf; old prints hung on the wall; an oriental carpet on the floor—anything, *anything* to relieve the tedium!

Translating this demand over to architecture, I think the parallel is obvious; contemporary architecture is in danger of boring us to death. It is tedious to behold; and more than anything else, we want *something to relieve the tedium*. Of course, it would be called archaism to expect niches with statues, extensive bas-relief, ponderous cornices, and other classic methods to serve our purpose today—although there are those among us who nostalgically demand these things. Note, for example, Henry Hope Reed. But two elements of architecture—as surely basic as the arch, the dome, the column, and the beam—are generally being forgotten, or, at best, relegated to the amusement park. These are color and texture. And why do so many architects shy from color and texture? Who knows? There are as many answers as there are critics writing about it. Some say lack of energy; some say lack of imagination; some say lack of knowledge. Some cry subservience; some cry egocentricity; some cry fear. But all seem to recognize the need.

Recall with me, for a moment, what these two words—texture and color—mean.

Texture, briefly, is three-dimensional surface enrichment. It is created by the interplay of light and shadow. Most commonly, we think of texture as being of a material, whether applied by hand or machine, or natural to the material, as it is with split stones and some brick. There is also exterior building texture, accomplished by the arrangement of exterior building details, or by the addition of decorative elements.

Because this last kind of texture, in its extreme form, is the first evidence of decadence in any architectural style, we sometimes forget that it is also intrinsic to any style at the height of its glory. It is the result of a complete familiarity with tools, possible only when fumbling and experimentation are over, and freedom of expression is fully attained. Primitive art frequently depends for its beauty on the *natural* texture of the materials. A well developed art form can control the materials and through them create texture.

Our architecture today is, of course, still in a period of experimentation. All the energy of our minds, the power of our machines, the genius of our culture is bent to the solution of a problem. Our tools are still not comfortable in our hands, the finished picture still not clear in our minds. Small wonder, then, that the expression is incomplete.

But while we strive, we need not neglect the beauty *natural* to the materials we use—color *and* texture within the materials.

In our smaller efforts—small in size, not necessarily in importance—we have shown evidence of understanding this. Think for a moment how stone and ceramics, marble and brick and glass are combined in much of the small commercial building around Los Angeles. They represent much more than tinsel and glamor and sell. They might well point a direction for all building. And inseparable from

this style is an understanding of the texture natural to materials, and a still greater knowledge of the refinement which can be accomplished by posing one material against another, combining many materials in the same expression.

Texture is to design what timbre is to tone, what personality is to performance, what clarity is to color. Neglect the one, and you may destroy the other.

Now, for a moment, let us look at color. Most of us know enough color theory to use it understandably. Or if we have forgotten, a short treatise like Birren's "New Horizons in Color" will quickly bring us up to date. The problem is less one of knowledge than of initiative; it is a matter of courage rather than culture. For today's architecture is almost colorless, and the few exciting exceptions which quickly come to mind only emphasize the point. Nearly a generation ago, Ralph Adams Cram could write, "The complete loss of color out of architecture is one of the curious phenomena of the Renaissance, casting its drab shadow in lengthening lines and ever-increasing gloom over the art of building in modern times."

These words are a sad commentary on the courage of Mr. Cram himself, and because they might have been written by any architect today, they might also be a sad commentary on the courage of all contemporary architecture.

For who else is to blame? Not the people for whom you build—if you *are* building for them. They want color! Nor the materials available to you. They have color! Masonry materials most of all.

So let us admit that color and texture are as necessary as form and function. The big question is, can they properly be acquired through the use of masonry materials.

Before answering that question, however, let us examine certain requirements of contemporary building which immediately seem to limit the use of masonry materials. The modern trend towards lightweight, thin wall construction might seem at first glance almost to preclude a consideration of such heavy materials as marble, stone, and brick until we realize that new developments in the use of these materials and new techniques for wall construction have made these materials perfectly adaptable to even our latest trends. You will be apprised of these by subsequent speakers before this conference is ended. We might remember here that building size and purpose dictate minimum limits of weight; and there seems to be little doubt that brick, stone, and marble, when used intelligently, can be kept within these limits.

Another important factor might be cost, until we realize that the cost of materials might have been a problem at times in the past and it may be again, but today it really is not. Most of our great buildings of the past decade could have been built for much less than they actually cost. There were sufficient funds available to choose expensive materials and expensive modes of construction. Some part of these funds might have been devoted to craftsmanship on much less expensive basic materials with much happier results. No, cost is not really a problem. It is frequently only an excuse.

What other limiting factors are there? None that I can think of except the backwardness of the masonry industries which have failed to maintain the interest of the architect or designer. And a lack of enterprise among these last.

So, for the moment, let us forget any reasons why these materials cannot be used, but instead focus our attention on possibilities which emphasize why they should be used.

Let us start with brick. Here is a material which has not really changed its form for many years. It is true that there are slight variations in size and shape which might make one brick

different from another. But a brick wall is essentially the same from one building to another. As a utilitarian building product, it can properly define mass; and because it is available in a wide variety of colors and color compositions, it can add a new dimension through color. It also provides texture, but the more common coursing of bricks is so familiar to us that, for practical purposes, the feeling for texture can be lost.

Yet brick has much more than a utilitarian value. It can provide great beauty and is completely adaptable to almost any scale. The slides you will see later on should prove beyond doubt that brick is properly a design medium with exciting possibilities which have not yet been probed.

If you are familiar with the 300-foot mosaic wall in the school at Villingby, Sweden, then you have in mind a whole gallery of compositions which can provide any imaginative architect with a magnificent point of departure.

In this country, we have not been so adventuresome, but we have multiple examples of imaginative brick setting, the execution of which throws less of a burden on the brick setter than it does on the architect or designer.

Brick can be architectonic; it can be sculpturesque; it can even be musical when set by the hands of a gifted craftsman. Its potential is limited only by the limits of your imagination. Create the demand, provide the incentive, and the craftsmen will be there or will soon develop. Architecture will be better for it, and we who must live with your architecture will live better because of it.

What about stone? Here you have an almost limitless palette of color and texture waiting for the more courageous of you to exhibit.

As with brick, you may think of stone as being all of a kind. You may think you know its scope, its possibilities, its limits. But when you realize that there is no well-defined color recognizable to us which does not have its counterpart in natural stone, and that these stones are readily available in almost limitless quantity everywhere in the country, and that they are adaptable to almost any size or shape, then you will realize that here is an almost perfect material for enhancing any building.

Once again the possibilities of stone are limited only by your imagination. If your vision is circumscribed by what you have seen in the past, you may think that stone is drab, and feel forced to go far afield in search of new materials. And this is one burden which you cannot throw back on the already sagging shoulders of the stone producer or fabricator. He has the material, magnificent in color and texture, and he has the equipment for satisfying your needs. You must provide the imagination and the incentive for experiment. Do this, and there will be opened for you a scope in design reaching far beyond your wildest dreams.

So with marble. The more than 250 varieties now available, running the full gamut of the rainbow in color, with inherent decorative schemes in every conceivable size and scale and pattern, offer a challenge to every architect who is worth his salt. And you might keep in mind that the problem of permanent finish which will make all these marbles available for exterior use is even now being studied and solved.

Once again the potential of marble is limited only by your imagination. If you think only of size and shape and position as you have known it in the past, you will be working in the idiom of the past. Sometimes the simple expedient of turning the slab, as was done on the Fraternal Order of Eagles Building in Atlanta, Georgia, can change this exquisite but still common material into one of startling new beauty.

The material is essentially finer than anything you can make by machine. It is much more adaptable to your designs than most other materials. It has a permanent beauty which

neither heat nor cold, biting sun or melting rain can destroy. It is a pliable yet permanent mould for your concept. It will do you justice.

So we have a group of fundamentally sound materials, beautiful in themselves, beautiful when used together. They are *proper* building materials. They have possibilities for beauty in expression which are truly limitless.

Modular Design With Masonry

Ralph Walker
Voorhees, Walker, Smith & Smith
New York, N. Y.

MR. SHEAR: *Our next speaker is most certainly known to most everyone in the building industry. Mr. Ralph Walker is a Past President of the American Institute of Architects and a member of its New York Chapter. He is a member of the Class of 1911 of Massachuetts Institute of Technology and was a Rotch Traveling Scholar. He belongs to many professional and art organizations and is an Academician of the National Academy of Design. He is also an honorary member of the Royal Institute of British Architects, several other foreign architectural societies, and a Vice President of the International Union of Architects.*

ANYBODY can design a building—in fact the average architect is continually hampered in taste by amateur clients who know more than he does; but it does take expert knowledge of how to put things together to achieve finally a continually satisfying result. To hazard a generality—the jointing of a material is more important than the material itself.

In these days one is almost tempted to say: "Masonry walls are obsolete! Metal cladding—glass—micarta—anything as long as it is panel construction." Masonry! Who brought up this subject anyway? Only an old fogey could be interested in such old-fashioned things as brick, stone or marble or granite. They are materials to give a superficial quality in interiors, surface

materials to make a Seagram Building, for example, even more an example of conspicuous waste; perhaps Italian travertine on the floor or one of the modern fried egg mosaics, but for construction they are certainly passé. The summer students in my office tell me they are no longer permitted to use them on their school problems. After all, don't all the kudos and the prizes, the masterpiece articles in "Fortune" acclaim the panel construction as the only modern construction, and proclaim the men who use them as "form makers?"

Perhaps it's my advanced years which led to my being asked to talk about masonry. My wife often makes a sage remark. We were listening to WOR's "Studio X" and she said: "That's a good record, although old; you generally expect old records to be cracked." After fifty years of architectural thinking this remark might well apply to me. I wonder, however, whether those other more modern records, now so often replayed, may not be cracked, also. So with no apologies for being an old fogey, record grooved, and cracked, I reiterate: "I said it, I said it, I said it—fifty years, fifty, fifty, I said it fifty years ago; masonry of all kinds is still a very desirable method of construction with many virtues and some faults." Certainly if you want long endurance and reasonable maintenance costs, as well as initial small capital investment, the masonry wall still shows to advantage. It strikes me as an amazing anachronism that this machine age panel wall must be washed painfully and completely by hand to maintain even a fair appearance. But we were to talk of the modular advantages of masonry construction.

We have been taught lately that *structural modular construction* is extremely economical, that if you can achieve a standard bay in which the tenant requirements may be adjusted, even with some compromise, the final building costs will reflect the rewards of standardization. In one sense this is true except that aesthetically the harsh cell-like appearance achieved, the uniformity we see in all building types, may be causing finally a loss of fine architectural character which other times have achieved. I am not too inclined to accept the structure as the only determining factor; after all, it is the cheapest part of the building. I continue in an attempt to find a tenant to use the module, and so far our clients, being what they are, are also adverse to the "all look alike" characteristics of mass production. I have found that modular construction does not mean necessarily that design costs are any smaller. In fact in building conditions as they now exist I find that more and more I must design the building completely on paper. There are, because of the completeness of design, real economies in the building itself and, while no paper design is ever complete, the on-the-job adjustments can be minimized.

If I may return for a moment to standardization of parts, I think we are too apt to be content with a small range of dimensions. We are content, for example, with 12"x12" or 12"x24" ceiling acoustic materials, and 8"x8" or 12"x12" so-called resilient floor tiles. These acceptances are really at variance with the underlying principle of the 4" module. The manufacturer has too rigidly set his jigs—but after all monotony is a matter of a taste.

I want to speak of two masonry buildings which our office designed on the modular basis: One an office building for the General Foods Corporation at White Plains, New York; the other the beginning of a Research Center for IBM at Poughkeepsie. The human use module is, of course, different in each case, and in the latter there were parts of the building so diverse in character that the use of a module of any kind might have caused difficulties. In both cases two sizes of brick were used: a smaller one for face brick averaging five courses of running bond, the back-up brick averaging four bricks to the exterior five. At

IBM RESEARCH CENTER, POUGHKEEPSIE, N. Y.

IBM we used the larger modular brick for pattern interest on the end walls and attic. Both buildings have very fine masonry walls, and generally are conceded so. In one case the general builder used a "lumper" in supplying labor to lay the brick; in the other the builder himself did the whole job. In both cases the builders, heretofore unprepared for modular work, said at the beginning of the project the wall would cost much more. The "lumper" however made a reasonable price for the labor because he recognized immediately that there were only a few different areas that he had to figure in relation to the walls, namely, all the panels between the windows were alike, all the spandrels were similar and each corner was the same. So all the masons had to do was to see that the vertical measurements were maintained and that joint alignment was precise.

Thus holding the vertical measurement paid off. The normal measurement creep in building construction was reduced to a minimum. The stairs were all alike, the radiator enclosure fitted without adjustment and horizontally, floors and ceilings were finished with remarkable speed. These by-products are of course usual in modular design but the general builder is loath to permit them to operate in cost analyses. He will admit an increased efficacy but will not put any dollar and cent gains against it in the budget.

The General Foods Building was designed to meet local requirements of the zoning, planning and fine arts commissions, and was particularly difficult because of the hilly terrain. Yet, as I said, the masonry labor contractor was content with the savings he made. It was the first job which he had ever done in which there were no clipped bricks.

The window wall—that is the *conventional* wall, as opposed to the panel wall, is one for which I have a high regard in that, quite contrary to amateur illumination engineers, it does reduce glare and also greatly diminishes the thermal problems, resulting in a low first cost for refrigeration, and of course extremely low operation costs. You may be interested to know that we do not have to cool these build-

GENERAL FOODS CORPORATION OFFICE BUILDING, WHITE PLAINS, N. Y.

ings on a sunny winter day. There are no human heat losses carried to poorly insulated walls in them—such as you find at General Motors, for example. The walls are purposely thick so as to remove as much of the glass area from the sun as possible. The depth the brick reveals therefore also has to be considered in modular relationship.

These are the brick sizes which have been used by me—each one is definitely modular in dimension:

Face Brick—1⅝″ x 3⅝″ x 7⅝″
1⅝″ x 3⅝″ x 11⅝″

Modular jumbo for back up—
3½″ x 3½″ x 7½″

I have never attempted to work out a modular pattern on standard size brick. I believe, however, that in general where the buildings are of great size special modular brick are necessary.

I have been interested in limestone and marble buildings—here are materials which can be readily cut to any size consistent with quarry facilities and the desire to have the stone used on its natural bed. With materials already flexible in common practice the 4″ module loses some of its importance as a part of the exterior design but it still remains important in relation to the modular interior dimensions, and of course the most important of all is that the floor heights and external modular dimensions should flow together

intimately. The ability to plan a floor and a ceiling so that all parts fit quickly and without the cutting of materials is something yet to be wholly attained, because most building laws require masonry walls about shafts, stairways, and so forth, and some difficulty is still found in achieving a modular result. (We need, and research men are already developing, thin sheet plastics to cover fragile insulation walls, eliminating plaster and paint, and some day soon we will, I am sure, achieve another fireproof glue besides cement.) Even then, however, on a well-planned floor the modular pattern can be maintained for 99% of the area. The modular exterior wall, as I have indicated, gives definite area patterns which are within a daily work output.

The stone masonry wall comes in modern practice to resemble the panel wall of metal and glass in that the units are large and thin in wall thickness. At the Belgian Embassy the unit is a piece of stone 4′ x 4′ and 4″ thick, tied into a concrete structural wall 6″ thick. The wall unit is approximately 12′ x 12′ into which a modular window is placed from the rear. The resulting wall thickness is relatively thin for a masonry wall but the reveal on the interior is increased by the need of space for the duct work accompanying air conditioning.

AFL-CIO BUILDING, WASHINGTON, D. C.

But the thinness of exterior walls is not a matter of great economic moment for I have seen more floor space wasted by badly coordinated cores and their relationship to the whole floor, and this economy, perhaps desirable in the city, does not exist on large country plots.

The relative costs of all wall sections are still based on that of 12″ brick walls with a normal window and when you add in extra costs for heating and cooling, the extra man-hour time needed to keep large glass areas respectable, the brick wall still maintains even with its greater thickness a relative cheapness.

I find a resistance to modular design among the craftsmen, and especially so in our office where we have men in our employ who have been there longer than some of the partners. We have developed techniques of our own, and with the accompanying inertia that home grown products develop we, who believe thoroughly in the system, must exert constant pressure to go on with the idea. As I said before, if the work designed is constantly changing in the sizes of the human use module there is little design economy, and you tend to find that even when it falls within the 4″ module possibility the little fractions seem to develop.

I have been interested in talking with foreign architects concerning modular design and find that even where 10 cm. is accepted, the modular idea is often associated with the resulting sizes in panels rather than with the basic module. There has been a very learned discourse in England on the relation of growth patterns in numbers to modular construction, but I think that even the simplest of these would unnecessarily complicate the use of a modular system.

Discussion

MR. JOHN KNOX SHEAR (*Presiding Chairman*): I have a question here of my own that I would like to direct to any one of the three speakers. It needs a little bit of a base. I will furnish that. I think we all love masonry. I think we have an inherent affinity for it, but I think there is a large and growing group of architects who have identified the fact that this love of masonry is associated with its quality of permanence, massiveness, a certain earthbound quality that it has, of association with depth, and so on.

As our buildings have risen higher and higher, and we have built more and more of the tall structures, I think there is some concern on the part of these people that the traditional patterns of masonry, and I refer to textures both inherent in the materials themselves and the textures produced by the joints, will no longer be in harmony with our knowledge of the diminishing mass of material.

Now the question. Do you, Mr. Walker, Mr. Bennett, Mr. Moore, whoever wants to grab this one, feel this industry must concern itself with or is concerning itself enough with new textures which may be associated with the new thinner uses of the material?

MR. WALKER: I heard recently that the masonry group, I forget whether it is the clay products group, has been studying this problem of getting a thin masonry, almost pile-like surface, backed up with fiber glass insulation and backed by another surface on the inside, in other words, carrying along the sandwich idea. I think the time is bound to come; I see no reason why it should not.

MR. SHEAR: We do hear of things going forward in that direction. I know we will hear some fairly startling things this afternoon. At the same time I gathered from both your remarks and Mr. Bennett's that you yourselves

are not particularly disturbed by the association of overtones with newer uses.

MR. BENNETT: It seems to me that the greatest thing that the industry which supplies the materials can do is to inform the architects from time to time just how things are made and what the possibilities are. I don't believe the purveyors of materials are responsible for the final result of how it is used. It is a matter of education, that the architects be given the opportunity. After all, when you get the credit—you get it when it is good, and the blame if it is bad.

MR. SHEAR: Mr. Moore, here is a question for you from Mr. Howard T. Fisher. You say everyone is in favor of texture. How do you reconcile this with the classic trends stressed by Mr. Bennett.

MR. MOORE: Perhaps it is a difference in the meaning of the word "everyone," when you talk about a classic trend. By that I understand you mean the rather severe group of people who use classic—

MR. FISHER: Mr. Bennett, I thought, made an explanation of the two trends in architecture, and I wonder if you could relate the texture that you felt everybody was in favor of—

MR. MOORE: The word "texture" is basic to any concept of visual measure. I may not have had time to distinguish between textures and material.

MR. WALKER: I disagree wholly with Dick Bennett's definition of classicism, when you come to look back through the classic forms in architecture. The Parthenon is an example. You would even come down to probably Salisbury as a very classic type of architecture without getting into Roman or Greek architecture. Classicism has never meant to me the stripping down of the fullness of an object. I think the modern world is using this word in a very bad sense, like the Communists are using the word, "democracy." The modern architect or philosopher is misusing the word "classic" in relationship to buildings that are stripped down without anything except a few curves. I don't think they are classic; I think they are meagre.

MR. SHEAR: Mr. Bennett, do you want to take that up? I have a question for you. This one asks: Your mention of LeCorbusier's chapel calls to mind his early interest in painting, that is, in the art of painting. Do you see as much opportunity of integration of art and building in masonry construction as in more plastic forms of material construction?

MR. BENNETT: It seems to me the answer to that question is this: The designer, the architect, the person who may be doing a piece of sculpture, no matter what the material is—the more limitation the better—the possibility for integration of art and building is always there.

MR. SHEAR: Mr. Moore, this question concerns the problem of preserving the original colors of marble in weather and temperature extremes. What are your specific recommendations?

MR. MOORE: I must tell you that I am not a marble man. I don't know the material as well as some of the people who will speak to you later. I think many of the marble materials which you have been thinking of specifically for interiors of the building will be available in a few years for the exterior. That should open up a whole new array of design possibilities which have not been available before. How soon that will be done is not within my province at the moment. But I think it is in the offing.

MR. SHEAR: You think some details of that will be discussed?

MR. MOORE: I am sure it will be discussed, either to deny everything I have been saying or to admit what I have been saying is possible.

PART TWO

Technology of Building With Masonry

PRESIDING CHAIRMAN:

John Knox Shear

MR. SHEAR: In this second session we turn our attention to the subject of technology of building with masonry. Having started on an aesthetic basis, which I must say I commend, we must nevertheless move quickly into things equally basic but in another dimension.

Reinforced Brick Masonry

Walter L. Dickey
Bechtel Corporation,
San Francisco, Calif.

MR. JOHN KNOX SHEAR: *The technology of building with masonry presents us with two men, an engineer and an architect, both coming out of backgrounds of broad experience. Our first speaker, Mr. Walter L. Dickey, has had a broad background, which has prepared him for his discussion today. Mr. Dickey has worked at it actively and practically, and has for many years now worked at it in the theoretical realm as an engineer. He is the chief structural engineer for the Bechtel Corporation. He is a civil engineering graduate of the California Institute of Technology and worked as a bricklayer while doing graduate work on masonry structures.*

Mr. Dickey is a member of the American Society of Civil Engineers, the American Standards Association Masonry Committee, the Structural Engineers Association of California, the Pacific Coast Building Officials Conference and the American Ordinance Association.

THIS is a description and discussion of the combining of modern reinforcing techniques with ancient and venerable brickwork, to solve problems of modern architectural expression and construction.

The subject of Reinforced Grouted Brick Masonry is one that is noted to tie into almost all the other topics of this conference. It provides flexibility in architectural design to achieve effectively the "Aesthetic Demands of Contemporary Architecture," including minimizing the normally great need for "crack fillers." It provides for combinations of "Colors and Textures" in almost any type

of pattern that might be desired. It provides for the achievement of "Modular Design," even the mixture of different modular systems within the same wall. It provides for almost any "Veneer" surfacing desired. It has been used in lieu of "applied veneer" in many instances. In so using it, the "Veneer and Face-bonded walls" would be homogenized with the structure.

The "Thermal Performance" is excellent. "Ceramic Veneer" can be used in this type construction. Also there have been instances in which "Natural Stone" was used as one wythe of the Reinforced Grouted Masonry. "Marble and Granite" might have been used although I do not know of specific instances. "Brick and Tile Research" has been conducted extensively evaluating this type of construction as well as providing information that can be used in unreinforced masonry. "In-the-wall Costs" are relatively good, and "Maintenance of Industrial and Public Buildings" is minimized by this type of construction. It has been used in "Residential Design" with striking results and is effective in construction to provide not only curtains but also structural shear elements. It has been used on "Hospitals" such as the large Veterans Hospital just outside of Los Angeles at Sepulveda. It has not only been used in "Schools" but the California State Division of Architecture, responsible for the design and construction of safe school buildings, was one of the leading organizations in the initial development of the technique.

So it touches the many facets of a Modern Masonry Conference.

Author's Combination of Practice and Theory

The author's early experience was on construction jobs as bricklayer laborer, hod carrier, brick layer, and brick layer foreman, primarily on brick and tile walls, partitions, etc. Theoretical training was at the California Institute of Technology with graduate work, particularly in masonry structures. Since then experience was as structural engineer in private practice and structural engineer for the power division of Bechtel Corporation. It was in the latter capacity that there was the responsibility for the design of one of the largest brick buildings in the western area, a power plant some 800 feet long, 90 feet high and 400 feet wide. There were of course many other similarly interesting responsibilities, in the tremendous and widespread activities of Bechtel Corporation.

The above theoretical and engineering training was valuable, but in design the practical experience was of even more value and aid in visualizing the problems of combining brick, mortar, grout and reinforcing into a homogeneous structural element. The problems of design are no more complex than design of reinforced concrete, but details of assembly sometimes tax the experience and practical ingenuity of the designer.

What Is RBM and RGBM?

The terms RBM and RGBM are abbreviations of "Reinforced Brick Masonry" and "Reinforced Grouted Brick Masonry." These should be defined of course, since they are the subject of this paper. RGBM for some time referred to the reinforced grouted work that was developed as a new method of construction, and which became most generally popular and effective. It consists of wythes of masonry with grout poured between, i.e. a grout collar joint to provide for reinforcing, to tie the wythes together, and to form a weather barrier. There are other forms of reinforced masonry but this is presently the most effective. . . . The rather clumsy term RGBM is now being dropped for the more euphonious RBM.

RBM is now being used as the generic term for all reinforced brick masonry, whether of the more popular grouted type, or the type with reinforcing in bed joints, or in filled cells or holes in the brick units, as will be discussed later.

From an architect's standpoint, RBM seems to offer the designer greater flexibility in treatment and use of finished materials than any other comparable material or method. There is little limitation in selection of masonry materials, of patterns, of types, of sizes, etc. The choice is greater even than in unreinforced masonry. In addition the finish surface or material is not applied merely as a skin or covering, it serves as part of the structure as well. It can be said that the finish becomes an active load-carrying participant rather than a passive load, or burden. It is a mystery why so little is known about the use of this method except in the area in which it was initially developed.

History

RBM was reported to have been used 140 years ago in England and later in France and in India. The author's first personal experience with reinforced brickwork was in 1911 on the construction of the State Hospital at Agnew. The reinforcing consisted of flat steel straps in the bed joints with notches or holes for vertical bars. The installation was not well regarded by the masons, they felt that "they had built the Pyramids without steel—and steel was not necessary." However, while reinforcement has been used for a long time and sometimes rather haphazardly, to strengthen masonry, reinforced brick masonry in the modern sense is a relatively new construction requiring new design procedures and new construction methods. In the past 20 years especially these have been developed from experimental investigations and observations of construction of hundreds of buildings under ordinary vertical loads, and under the influence of earthquakes. The trained and practical observation as well as the laboratory work has confirmed the soundness of the scheme.

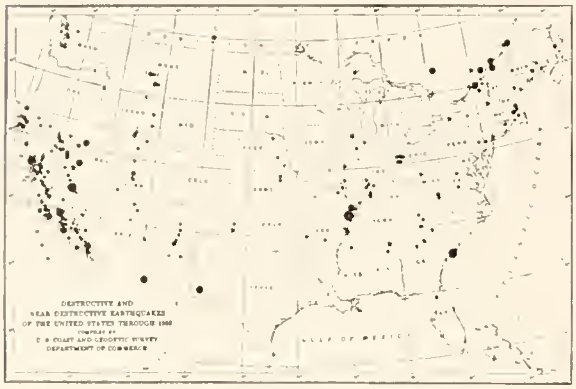
Long Beach Earthquake

RBM was developed and has experienced its greatest use and improvement in the Southern California area. It was there that the Long Beach quake of 1933 shook down the cheaply built, poorly designed, loosely tied, boom built, brick structures. Brick were salvaged and cleaned from the debris by the simple expedient of sweeping off the loose, powdery mortar dust. It was said at the time that the purpose of the mortar must have been to "keep the brick apart" rather than to bond them together. There was an example of a stack of brick on a pallet adjacent to a collapsed brick structure. The pile was still undisturbed and standing relatively true, not having mortar to keep the brick apart, while the brick building was a pile of debris similar to the photo below of the church in Bakersfield.

OLD BRICK CHURCH AFTER BAKERSFIELD EARTHQUAKE OF 1952

The old church in the foreground, built with old brick masonry design methods, was completely destroyed. The new annex in the background, built of 8″ RBM, is unharmed.

Some of the brick structures that were demolished by the Long Beach quake were identical to many of the brick structures now built in the East (since the last big earthquake occurred in the area). The first quake, for many, will probably be the last. We do not predict a quake soon, but the records, as shown on the seismic chart, show quakes have occurred here in the past.



Although the greatest number of recent quakes have occurred in the West, California in particular, it must be noted that some of the largest known have occurred in the Eastern area.

DESTRUCTIVE AND NEAR DESTRUCTIVE EARTHQUAKES OF THE U. S. THROUGH 1950

While the greatest number of earthquakes has occurred in the West, particularly California, some of the largest on record have occurred in the Eastern area.

Since the buildings referred to had not been designed to resist any lateral force the factor of safety against lateral force might be FS x O= O—so hence the collapse.

The buildings that suffered worst as a group were the school buildings. These had certain undesirable characteristics in common. There was excessive, massive, ornate gingerbread "embellishment" around the top. There were high window openings, imposing top-heavy entrances, a minimum of structural material to back up the fancy facing, a minimum of roof structure and detail connection—effect of undue emphasis of a competitive bidding system—inadequate inspection of the quality with resultant minimum cement content, and low regard for workmanship.

The sight and memory of brick buildings collapsed as piles of debris was a factor that practically eliminated the popular demand for brick production, especially perhaps since so much "used" brick was available in such good condition, unbroken and hardly stained.

It was obvious then that a different type of construction must be developed.

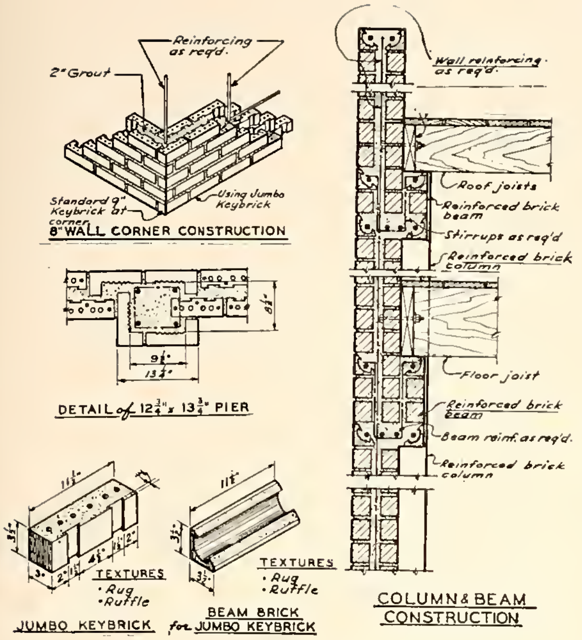
Development of RBM

Recognizing the advantages of brick construction and the serious need for developing structures to resist quakes safely, the Southern California groups initiated active programs of engineering study. Mr. Harry Bolin was one of the aggressive and far-seeing engineers who did much to develop the scheme of grouted reinforced masonry and to conduct tests which verified the soundness of the various factors. He established facts where there had been but theory before.

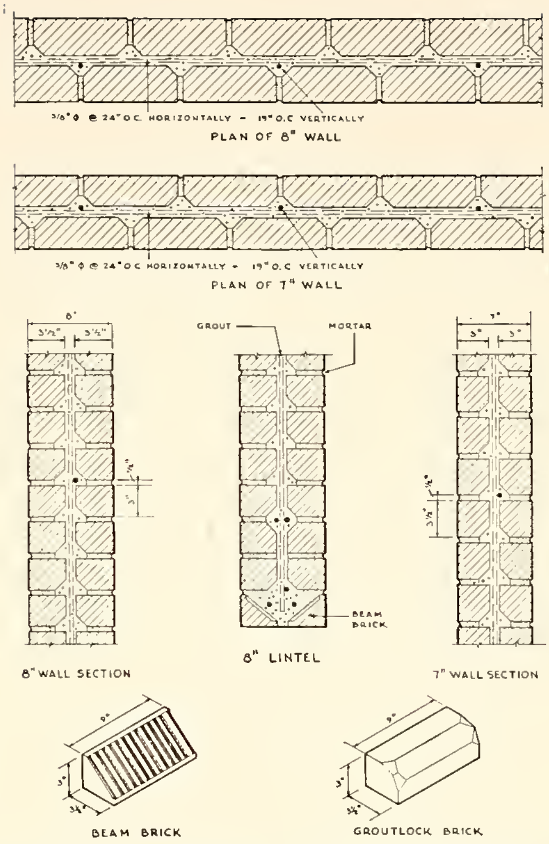
One series of tests was especially interesting and valuable. It established that grout could, and should, be poured very wet, even "sloppy," apparently violating the engineering concept of "water cement ratio." The grout might be poured, with a W/C ratio to result in 1600 psi concrete, but due to the absorption of the brick and the subsequent curing effect, the grout core when actually tested could develop 5000-6000 psi in 28 days. Also, when poured thusly, the bond was extremely high.

The first noteworthy example of that program was the Vermont Avenue School built in 1937.

Many types of masonry were attempted, special shapes were developed. The Grout Lock Brick and the Port Costa Key Brick shown in the sketches are two. The mechanical key to the brick is a desirable feature, eliminating one of the hazards of poor workmanship, namely poor bond. However, simul-



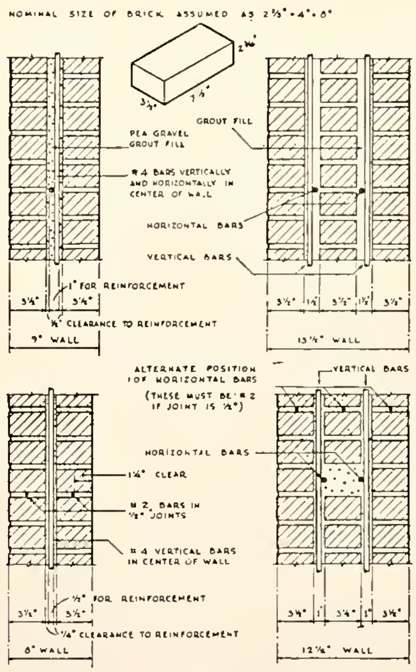
PORT COSTA KEY BRICK GROUTED MASONRY



TYPICAL "GROUTLOCK" BRICK CONSTRUCTION

Sketch at upper right shows typical wall sections constructed with special brick known as "Groutlock" brick. The beveled edges of these units provide more space for both vertical and horizontal reinforcing, and give the impression of mechanical bond. Although such special shaped brick as shown here, on the Port Costa Key brick details, and L's and soaps—used on the Vermont School—have been developed in some areas for RBM, it can be designed and constructed with the conventional brick shapes and sizes found all over the country.

Sketch at lower right illustrates various RBM wall sections and thicknesses constructed with modular brick of conventional size. Variations are possible as brick sizes vary locally. In most cases the variation will be largely in the over-all wall thickness when brick of different widths are used. Thickness of vertical or horizontal joints is determined by the size of reinforcing bars used. A minimum of ¼ in. clearance should be maintained between the bars and the masonry units except that No. 2 (¼ in.) bars may be used in ½ in. joints.



VARIOUS RBM WALL SECTIONS WITH CONVENTIONAL SIZE BRICK

taneously research in mortar and grout had disclosed the fact that bond between brick and mortar could be so good as to be better than the strength of the material, under proper conditions. Therefore there was no need for special shapes, ordinary common brick of any shape and size would do. The only special consideration was good workmanship, i.e., clean moist brick, good plastic cement mortar, sloppy wet cement grout. Other masonry units such as tile, stone, concrete block, etc., could serve.

Present RBM Data

There is a wealth of material published on RBM but two publications are especially recommended as covering the subject quite thoroughly and in considerable detail. One is the "Technical Notes on Brick and Tile," Structural Clay Products Institute, Volume 5, No. 1, 2, 3, and 4. Another is the very excellent book, "Reinforced Brick Masonry and Lateral Force Design," by Mr. Harry C. Plummer of the Structural Clay Products Institute and Mr. John A. Blume, one of the leading structural engineers of the west.

A good guide to the design of RBM, in the western areas especially, is the Uniform Building Code developed by the International Conference of Building Officials. One of our Conference Committees also prepared a booklet as a practical aid to inspectors of RBM, "Reinforced Grouted Brick Masonry—Field Inspectors Handbook."

These describe construction procedures and some effective methods to aid in accomplishing them. They emphasize the importance of good workmanship and continuous inspection to achieve it.

The importance of the inspection is to be noted in the different values of design strength which are permitted in the Design Tables of the UBC. The design strength permitted is considerably higher for continuously inspected structures than for those not inspected.

Types of RBM

As mentioned before there are many effective types of Reinforced Brick Masonry. Some of these are listed below. The item in common is the use of masonry elements and reinforcing bonded together by a cementitious material, generally cement mortar and grout.

Stone Masonry
: Stones set in mortar

Cavity Wall Masonry
: Space provided between wythes

Reinforced Hollow Unit Masonry
: The units contain hollow spaces, and reinforcing may be in joints or in filled cells.

Reinforced Solid Masonry
: Solid Masonry with the bars in the bed joint or between soaps, for example. (Includes SCR & Brix Blox, etc.)

Reinforced Grouted Masonry
: Wythes bonded together with grout collar joint between.

Composite Construction
: Might be similar to reinforced grouted masonry, with hollow units in one wythe and solid in another.

Improved use of mortar was developed in the search for adequate reinforcing methods. The mortar of the new RBM is almost as unique a feature as is the reinforcing, and is a feature that insures the action of RBM as a homogeneous element.

Two of the above, Composite, referred to frequently, and SCR are described in more detail. The Brick Block, a form of reinforced solid masonry, is mentioned briefly.

There have been quite extensive tests on many of the aspects of the above types, too numerous to mention in this paper other than merely in passing, and to emphasize that they verify the theories.

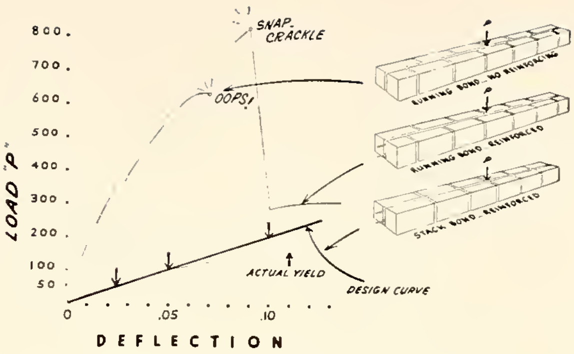
Composite Grouted Masonry Construction

This may be of many types, and one, the combination of structural glazed tile and common brick, is described here as an example. This type was used in a plant in which there were laboratory, office, and storage rooms. Along one side wall there was an outer finish face, which was entirely of a Norman unit stretcher bond. The inner wythe in the storage area was a jumbo brick, economical of material and labor. The laboratory was formed by intersecting walls of reinforced hollow glazed tile and by having the interior wythes of the exterior wall composed of glazed tile, bonded to the grout collar similar to the brick. Then in the office space adjacent in this same exterior wall, the interior wythe was a buff face brick in lieu of the Norman, jumbo or glazed tile. That particular wall was an example, to a small degree, of the freedom and functional expression that might be achieved with RBM.

The design of such composite shapes requires a thorough visualization of stress paths, requiring that one delve into the higher orders of witchcraft.

Recognizing the uncertainties, the author participated in some tests which were made on reinforced beams which verified many items rather satisfactorily. Results of the tests of clay tile beams with their complex interior shapes are indicated on the chart.

The chart (right above) indicates that masonry, in stack bond, complies with the design values permitted. It also emphasizes that masonry is a good material on its own, without reinforcing. It indicates also the comparative value of stack vs. running bond. Since the stack bond performed as well as design values would require, we should note that the running bond is so much better than the stack bond, rather than stating that the stack bond is so much worse than the running bond. In other words:



TESTS OF STRUCTURAL CLAY TILE

The type tested is shown as above. The three arrows on Design Curve show Calculated values for "uninspected," "inspected," "ultimate." This illustrates, not how poor stack bond is, but how excellent is masonry.

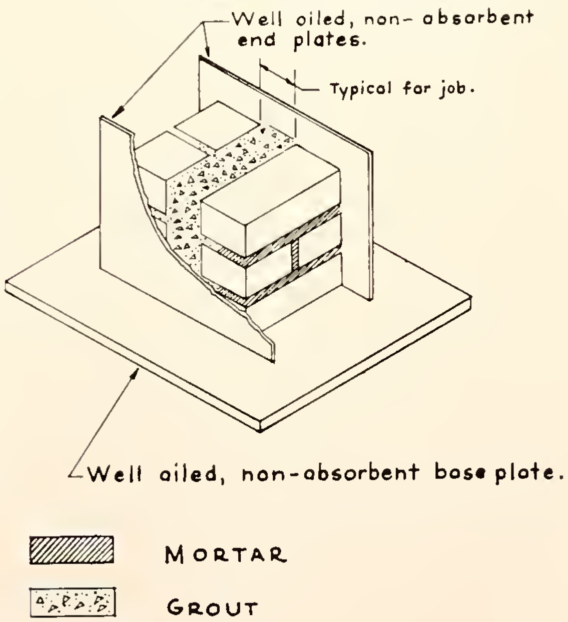
"The glass is half full!" not "the glass is half empty!"

The sections of composite brick and tile construction illustrated on next page are for further clarification of the type.

The test method which was used to check the increase of strength achieved by the grout as poured between the brick is shown in the sketch below.

Grout should be poured into place very wet to make thorough intimate bond with the

TYPICAL MASONRY TEST PRISM



masonry and reinforcing. The porous volume of masonry then sucks the water from the grout core leaving it with an excellent, effective water cement ratio. The tests showed that the grout samples developed 1600 psi in 28 days. However the grout core, taken from the masonry enclosure developed from 5000 to 6000 psi.

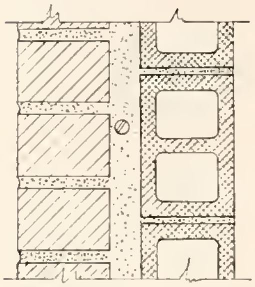
SCR

SCR is a through wall type of construction similar to partition tile or concrete block. The masonry units are of clay like common brick but are the full width of the partition for a single wythe wall. Horizontal reinforcing in the form of small bars or "ladder" reinforcing can be placed very easily in the mortar joints. Vertical reinforcing can be provided but not with the same ease.

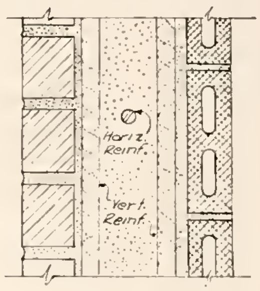
Structural clay tile has greater flexibility in the placing of reinforcing, similar to the more conventional reinforced hollow masonry, or concrete block work. Both SCR and tile demonstrate the efficiency of providing an architectural finish material which serves simultaneously as the structural element. These types of construction are especially well suited for economical curtain wall function, or partitions for space division.

They resist lateral forces of wind or earthquake and receive stability from the fact that they are generally spanning horizontally between relatively closely spaced supports, such as from column to column or between intersections of walls. These intersections generally occur with adequate frequency so that no special structural frame need be added. An ordinary wall is laid and no special provision need be made for it to be structurally satisfactory. If necessary however, elements such as reinforced masonry pilasters may be added. They can be quite economical if properly detailed so there is minimum interruption of the mason's work. They may be exterior pilasters or may be reinforcing bars in the wall between soaps.

REINFORCED GROUTED BRICK & TILE CONSTRUCTION



Typical Vertical Wall Section



Vertical Section at Pilaster

An example of the effective use of SCR is illustrated in a school building plan and scheme developed by the Structural Clay Products Research Foundation and entitled "SCR school design concept." This concept was developed for areas not subject to the hazards of earthquake and is quite economical. "First SCR Concept School goes for $6.71 per square foot," the journal *Masonry Building* stated recently.

The "Boonville-Boone Township School" plan for masonry building costs less than $10 per square foot. It features partitions laid out with returns or intersections. In this manner the SCR concept could be revised slightly to add reinforcing for earthquake, tornado and blast resistance.

It would merely be necessary, for example, to provide that the wall portions span easily between vertical elements, which can be returns, pilasters, or "soap" reinforced elements, and the tops of the vertically reinforced elements supported laterally by the roof structure.

RBM Advantages

Savings In Steel Reinforcing

It is recognized that masonry shows less shrinkage cracking than concrete and therefore customarily less temperature reinforcing is required for masonry walls than for concrete walls. In addition unreinforced masonry panels can be included between reinforced portions for even greater savings. These savings in reinforcing steel might be very important, especially during times of acute steel shortages. In some instances the supporting structure can be incorporated in the masonry with no additional reinforcing.

The table below shows the comparison of temperature steel required in masonry walls of various thicknesses as compared to that required for reinforced concrete walls. Concrete requires .0025 x area each way, but masonry .002 x area, or .001 x area if divided equally vertically and horizontally, i.e. concrete requires 2½ times as much as masonry.

Savings In Structural Steel Support

Advantage can be taken of the high compressive strength of masonry to carry vertical loads effectively within the wall. Then, if there is other consideration, such as lateral force or moment imposed, special reinforcing can be added. In this way many building types can be constructed without requirement for supporting structural steel.

Economy of Reinforcing and Laying

Economy of placement is effected since the reinforcing can be placed easily and economically by the masons as desired.

Workmanship is important in all masonry work, but some of the uncertainty is removed by the pouring of the grout. It provides a weather barrier. It bonds the wythes securely together, it fills the portions of bed joint that may not have been filled full, it fills the back

MINIMUM WALL REINFORCING (UBC)

REINFORCED BRICK				REINFORCED CONCRETE			
Wall (t)	As/ft. ea. way	bars & spcg	Weight psf	Weight psf	bars & spcg	As/ft. ea. way	Wall (t)
6″	.072	¼@9 ⅜@18	.49	1.22	⅜@8 ½@13	.18	6″
8″	.096	¼@6 ⅜@13	.65	1.62	⅜@5½ ½@10	.24	8″
10″	.120	⅜@11 ½@18	.81	2.04	½@8 ⅝@12	.30	10″
12″	.144	⅜@8½ ½@16	.98	2.45	½@6½ ⅝@10	.36	12″

of the head joints providing good bond in the event the mason had not used full shoved joints. In fact some careful workmen leave the inside edges of the joint open so the grout will flow in and develop good mechanical bond in addition to adhesion. When RGBM was initiated into the Utah area in a power plant program, it was necessary for the author to spend a few days indoctrinating the masons. Here are some examples of what the masons were told:

"Don't spread such a full bed—it squeezes out into the grout space.

"Put more water in the grout so it is sloppy and pours easier.

"Don't put so much mortar on the head joints, it's better if the back edge is not full than for mortar to extrude or drop into grout space.

"Don't furrow the bed—merely swipe it.

"Don't wet the brick too much, they won't dry up the grout core.

"Don't put those headers across—do it as shown in the drawings.

"Don't put that angle over the opening, you don't need it and it will rust.

"Puddle the grout quick while it is still wet—don't wait.

"Don't bother to tie the bars, you jiggle them too much, just lay them in."

After a short while one of the contractor's foremen said: "But those are all things that will help us save money; we have a lump sum contract!" After that he was very cooperative and helpful and made constructive suggestions himself.

Economy of Reinforcing Walls

It is recognized that steel reinforcing adds strength to walls, particularly with regard to buckling tendencies. This is recognized to a certain degree in the Uniform Building Code where the H/D ratio permitted for unreinforced bearing walls is 20, but for reinforced walls the H/D may safely be increased to 25. The additional strength is also recognized in 'non-bearing walls' in which the limitation for H/D is 20 for unreinforced walls but is 30 for reinforced walls.

An example of the practical result of this additional value would be for a story height of 20 feet. Obviously it would be necessary to use a wall thickness of 12 inches for unreinforced masonry but the grouted reinforced masonry could be 8 inches thin!

The unreinforced wall would require 50% more brick and labor and would add 50% more weight to be carried by the supporting structure. The foundation would have to support the additional wall weight, the additional structure weight and its own consequent additional weight.

Also, of course, by a little exercise of imagination it might be possible to eliminate much of the supporting structure, incorporating it within the reinforcing and strength of the RBM.

Bond Beam

The "Bond Beam" is another element that can be built into the masonry effectively. The masons build to the bond beam area and continue right on through, placing the reinforcing as they go. This is as opposed to details which too frequently require that the masons stop when they come to the bond beam area. Then carpenters come in to build forms, steel men to place reinforcing, concrete men to pour the beam, carpenters to strip and the masons to return and continue with the brickwork—all of which makes the hair of the superintendent charged with the coordination and cost of construction turn grey.

Bond beams of RBM were used effectively on the P. G. & E. Contra Costa Steam Plant, a building some 800′ long, 450′ wide and 90′ high. (Described in greater detail in ASCE Separate No. 342, No. 540 and an article in Engineering News—Record, July 5, 1951.) This plant was designed for a higher

assumed seismic coefficient than generally considered adequate. In spite of the high design lateral force, and the 27-foot spans, the bond beams were of RBM, as were the high elements between the "slotted" windows. This enabled the masonry construction to proceed economically without interruption.

As mentioned before, this brick building is some 800′ long and it is to be noted that there are no visible cracks in the front, rear, or intermediate walls, although there are cracks in the concrete base portion at about 9 foot centers.

Design

The structural design theory for RBM is identical to the design theory for reinforced concrete, except that certain different numerical values are involved. Although the design is so similar to our familiar reinforced concrete design, certain portions are discussed here for greater clarity. For example the basic assumptions are:

1. The materials are stressed within the elastic limits so Hooke's Law applies, i.e., "stress proportional to strain."
2. Plane sections before bending are assumed to remain plane after bending.
3. Tension in the masonry is neglected (except for unreinforced masonry portions).
4. Bond is developed between steel and masonry units.

On the basis of these assumptions, which result in rather conservative structures, the following approximate formula may be used.

$$M\ (\text{steel}) = \tfrac{7}{8} A_{std}$$
$$M\ (\text{masonry}) = f \times \frac{bd^2}{6}$$

Formulae can be derived and set up in form similar to those for concrete for "exact" solutions, e. g., $db^2 = M/K$, and same procedures followed including:

$$v = \frac{V}{bjd} \qquad u = \frac{V}{\Sigma ojd}$$

Although the design of RBM is basically identical to the design of reinforced concrete, the actual RBM details might tax the ingenuity of some designers. He does not have quite the freedom of placement that he has in reinforced concrete. He must recognize and visualize how the structure will be built by bricklayers placing modular units in a definite pattern. He always keeps in mind, of course, the basic factor of tying all parts of the structure together. As in other architectural design,

TABLE OF STRESSES (Assume f'_m & f'_c = 2000 psi)

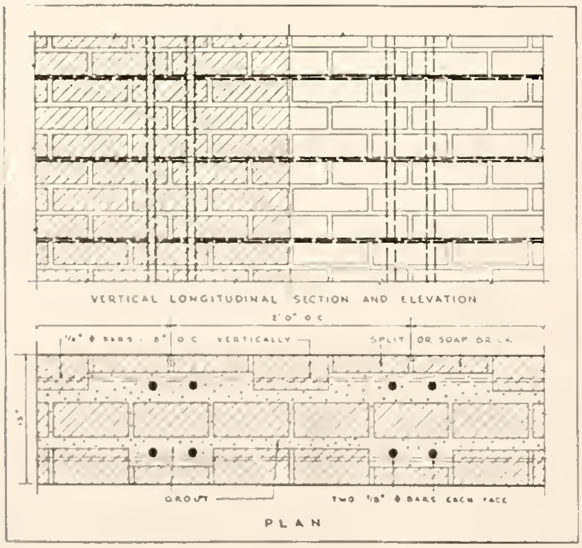
Types of Stress	RBM		Reinforced Concrete	
Compressed—Flexural	$f_m = .33 f'_m$	670	$f = .45$	900
—Axial	$f_m = .16 f'_m$	320	$f_c = .18$	360
Bearing	$f_m = .25 f'_m$	500	$f_c = .25$	500
Shear—no web reinf.	v_m	50	$v_c = .03$	60
Shear with web reinf.	v	150	$v = .12$	240
Bond, Def. bars	$u_m =$	160	$u_c = .10$	200
Modulus of Elasticity	$E_m = 1000 f'_m$	—	$E_c = 1000$	—
Steel, tension		18,000 psi		18,000 psi

it is imperative that the designer keep clearly in mind and execute completely a comprehensive *scheme* of framing to resist the loads. For example, a load on a *slab* is carried to *beams* which are carried to *girders* which are carried on *columns*, which are carried by *foundation pads*.

All elements of that scheme must be satisfactorily checked that no one little link in the chain will be overstressed, or overlooked. It might be emphasized here that the amount of material is not nearly as important as its proper placement. As on Marilyn Monroe, the amount of material is not as important as is the proper distribution in the right places.

Another item of growing popular concern is consideration of blast resistant design. The primary consideration in masonry structures is ease of placement of reinforcing to resist the very high loading assumptions, and freedom in providing for tying all parts into an integral structure, one that will "hang together."

An RBM wall designed for blast resistance is shown in the figure below. As can be seen this wall is heavily reinforced and "soaps" or split brick are used so the reinforcing may be placed nearer the outside surfaces.



RBM BLAST RESISTANT WALL

It might be well for the structural designer of any plant to check our financial tax structure and the benefits of fast "write-off" that may be utilized for plants designed to resist atomic blast.

Uses of RBM

Following are some examples of the freedom of expression in this medium. The list is merely to show some different types of examples of structures. Some are economical solutions to simple problems and some are to illustrate and emphasize the principle that one need not be bound to simple rectangles when building with brick. Some are simple conventional solutions and some are unusual.

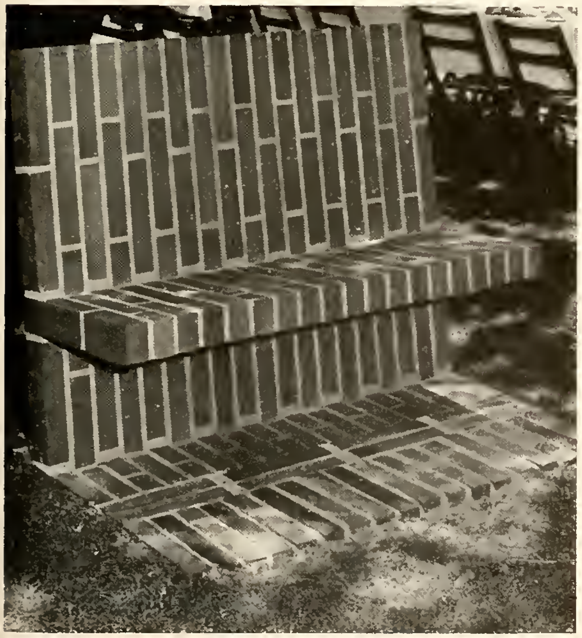
Proof of the adaptability of RBM would be shown by the long list of structures in which that type of construction has been successfully used during the past 30 or more years. Space does not permit listing them but they include large industrial and commercial buildings (warehouses, power plants, stores and factories), public schools, college and university buildings, hospitals, VA Hospital in Los Angeles, churches, public buildings, residential buildings and such special structures as storage bins (circular or rectangular), highway bridges, bleachers, etc. Even in structures not requiring design against lateral forces, RBM lintels are being used more and more by many architectural and engineering offices. Also bearing walls are reinforced because of the economy of masonry material and labor.

A complete listing of all structures utilizing RBM would show its versatility and acceptance by engineers and architects.

The simple lintel can be effectively built with reinforcing imbedded in the joint. This is as opposed to the cost and inconvenience of steel lintels and shelf angles. Not only is the RBM lintel less costly than structural steel, but the hazard of corrosion with consequent cracking

of masonry is reduced. In addition RBM eliminates the need for maintenance painting. Also fire hazard is reduced because the reinforcing of the RBM lintel has suitable and adequate cover for fire protection.

An example of an unusual use of brick is shown in the photograph of the garden bench. It indicates a certain freedom in the use of the masonry differing from the conventional brick paving or brick walls. Due to its rather unbelievable shape (i.e. cantilevered brick) it has presented a challenge and has been severely tested by groups of men at a stag barbecue. They jumped up and down on the outer edge to see if by singing and jumping in unison they could break the brick cantilever seat. The only damage so far was one skinned shin due to a slight unsteadiness of one tester.



GARDEN BENCH

Originally the bench had been designed for the brick to be placed "flat", 2½" thick rather than 4" thick. Since the owner, however, could not overcome his psychological block that brick is intended only for bearing and not for cantilevers, he would rather have it heavier. This reaction is a small example of the need for imagination in design and for sound public education in this matter. The best education of course is physical example, and we need more modern derring-do.

Another example of the effective use of rein-

PALO ALTO CITY HALL LOBBY

forced brick is the curved wall at the end of the Palo Alto City Hall lobby. This is a reinforced grouted wall "cantilevered" above a concrete floor, receiving no lateral support at the top, and over 10 feet high. However, by curving the wall we not only achieve a desired dramatic effect in the lobby but provide stability similar to the stability demonstrated in a *serpentine single thickness brick wall* on Thomas Jefferson's estate, built in the 1700's. Proper use of shape is the factor making Jefferson's serpentine wall so effective.

Chimneys

Chimneys can be constructed rather economically of RBM. Chimney design is discussed in excellent articles in the July and August issues of "Masonry Builder" and also in SCPI Technical Notes of April and March 1955, Vol. 6, No. 3 and No. 4. Another good design guide, and one which includes not only stress due to wind and weight but also due to temperature, is the ACI Standard Specification

LIGHT STANDARD

This effect is achieved by threading a concrete prestressing rod through the draw holes of the brick. It illustrates a large and little explored field. There have been some examples of "stressed" masonry like "Stresscrete" which uses stressing rods in concrete block panels, but there has been no very great application of the principle to masonry.

for Design of Reinforced Concrete Chimneys, ACI 505-54. Economy of seismic design is discussed in Dr. Housner's paper published in ACI, 1956.

The proper sizing of stacks is a problem, not merely of draft consideration and stress but, due to our increasing concentration of industry, of selecting the most economical combinations of height and top diameter (since top I.D. establishes flue gas discharge velocity) for a desired reduction of the concentration of noxious flue gas discharge. The interrelated cost factors are, of course:

Construction cost increase with height increase.

Construction cost increase with top diameter increase.

Pumping or fan cost decrease with height increase. (Draft gain.)

Pumping cost decrease with top diameter increase.

Dilution gain with height increase and concentration increase with top diameter increase.

Given the solution to the above, frequently made more interesting and complex by earthquake considerations, the engineer may find an economical solution in RBM, especially in the lower stacks somewhere under 200′. Any desired diameter, thickness and taper of diameter or thickness can be achieved easily. The more modern plants discharge gases at relatively low temperatures so separate linings to resist extremely high temperatures are not required. Frequently the interior wythe can be constructed of hard burned clay brick. The variation in thickness that is required for greatest economy is easily achieved by varying the number of wythes and the thickness of the collar joint. A simplification of the running bond was used effectively some time ago to provide for the variation in circumference, or length of course. The bottom of the courses was started with some wedge shaped pieces and varying bed joints so that the courses were continuous "spirals"—round and round without need for cutting brick to maintain "bond" in the coursing. Then to speed production a dou-

REINFORCED BRICK WALL

Striking color and texture effects can be achieved by using different brick in a single wall.

ble pitch "screw thread" was used. Two bricklayers could work simultaneously on a wythe, the faster one of course catching up to the slower one. The contest was obvious, up on a stage in full view of the entire project, and the production was quite high in quantity as in elevation. Some said that the "screw" bond arrangement was quite appropriately named.

Conclusion

We have described the details, advantages, and disadvantages of RBM. Although RBM was developed initially in the west to meet a need for an economical earthquake resistant construction, it has certain inherent qualities making it effective in any area. As a consequence it may make the use of masonry feasible and more desirable than some other material in many instances. Furthermore no area is entirely free from earthquakes; some of the strongest known have occurred in the east. It might therefore be well to take advantage of RBM's inherent safety factor.

To sum up:

RBM is the technique of laying exterior and interior wythes of masonry with a grout collar joint in which reinforcement is placed.

It provides masonry surfaces of elements of different heights, types and coursing, all incorporated into a homogeneous structure.

It has an adaptability and freedom of expression which could be more fully realized.

Design theory is identical to reinforced concrete design theory.

Validity of the principles and theory have been established by test.

It has a tremendous factor of safety over permitted design values.

It is subject to some typical masonry disadvantages, namely, modular restrictions of size or placement, and sensitivity to human workmanship. It is new and masons must be trained in slightly different techniques.

It has several advantages, for instance:

An ageless and warm beauty, with interesting texture and pattern.

A relatively low cost of placement.

An elimination of certain human equation factors.

A low maintenance cost.

Excellent resistance to cracking and differential settlement.

A finish wall that serves as a structural element.

High earthquake resistance.

Good atomic blast resistance.

Good weather resistance.

This discussion will, I hope, help enrich the vocabulary of the architect and engineer who seeks full, free, uninhibited expression of his creative imagination as well as function. It may also provide food for thought for those who seek economy—better buildings at lower cost.

Cavity, Veneer and Face-Bonded Walls

Walker O. Cain

McKim, Mead & White,

New York, N. Y.

MR. SHEAR: *Our next speaker is Mr. Walker O. Cain of the distinguished New York architectural firm of McKim, Mead & White, where he is a partner. Mr. Cain has a Bachelor of Architecture degree from Western Reserve University, a Master of Fine Arts from Princeton, and is a Fellow of the American Academy in Rome. A member of the American Institute of Architects, he is on the Executive Committee of the New York Chapter. He is also Vice President of the Architectural League of New York City and a Trustee of the American Academy in Rome.*

Mr. Cain's office has, over the past years, done some particular work in cavity wall construction, which he will speak to you about. He has been asked as well to address himself to subjects of veneer and face-bonded walls.

OUR continuing experiences with low-cost dormitories led us to the development, together with the firm of Severud-Elstad & Krueger, and Edmund J. Rappoli, builder, of the system known to many of you as the "edge-form" method of pre-cast concrete construction. It involves the mass production of the vertical components of a building (exterior walls, corridor walls and partitions) and linking them by poured floor slabs. The structural design is such that columns and beams are virtually eliminated from those parts of the structure where the system is used; more conventional construction being limited to rooms such as lounges and dining rooms requiring longer spans.

Without dwelling on the techniques of mass production and the assembly of com-

ponents at this particular meeting, it can be said that within the limits of problems to be solved, our system has proven to be a speedy, durable, and economical solution to the low-cost dormitory. Of greater interest here is the development of an appropriate outer skin for the structural frame referred to above. Among its requirements were that it be (1) low in construction costs, (2) low in maintenance costs, (3) durable, (4) weather-resistant, (5) attractive in appearance. Another requirement was that it have the characteristic of aging in an attractive manner. On many campuses the dormitory must furthermore relate well to other materials of the existing campus buildings.

Dealing as we were with "prefabrication" it was natural to consider skins made of large factory-built pieces, needing only to be raised and buttoned into place. At the period of our initial investigation, and continuing only slightly less so since, metal assemblies, despite many advantages, carried a cost penalty which in the end eliminated them from the low-cost bracket. Other architects have confirmed this in their subsequent applications of our system.

Our studies also showed that precast concrete exterior panels, to meet cost limitations, had to be quite large. The problem here was not their weight or the erection difficulties, but their coefficient of expansion. In New England where most of these buildings are located, the climatic variances present serious problems for any material, especially the problem of movement due to temperature changes. Further, the larger the unit, the greater the change of dimension. It developed that an economically large precast concrete exterior panel would come and go enough to make it extremely doubtful whether the joints would hold.

We finally found a solution to our problems in a 4″ common brick skin, separated by 2″ of air from the structural frame, and tied to it by metal anchors. This outer layer of brick was often carried on an extension of the 2nd floor slab and ran 3 stories up to an extension of the roof slab. The first story, often housing the special rooms, was usually treated differently, with large glass areas, and walls sheathed with special brick in patterns. We looked on this solution as a happy coincidence of an attractive, quality material and a low budget, not always an architect's lot.

It should be mentioned that this application of brick demands a reasonably high standard of performance by the bricklayers. Maintaining the essential 2″ air space free of fallen mortar was accomplished by hanging wooden lath in the void to catch the spillage. The metal ties were ideal collecting points for fallen mortar and would, if strict supervision were relaxed, produce "bridges" or conduits for moisture to follow into the walls. Weep holes at the base of the wall were provided and they too had to be kept clear of mortar. Other details, however, were so familiar and tested by time that over-all economies produced a quite satisfactory application of this material.

The application of stone to the surfaces of buildings has for centuries posed technical as well as philosophic-aesthetic problems for the architect. At meetings such as this we hear something of each. The former are the most tangible and perhaps the easiest to solve; the latter, having as they do the component of time, seem never to be solved for more than a moment. They do have in common the fact that veneer and face-bonded construction is essentially one of sheathing less precious material with more precious material—a technical problem in economy and an aesthetic one in expression.

By definition we refer to face-bonded walls as those in which 20% or more of the exposed surface is bonded to its backing. Anything less is generally considered veneer. Historically, both are of ancient lineage and appear con-

stantly throughout construction history. When we read that Augustus "found Rome a city of brick and left it a city of marble," we acknowledge it a feat even in marble veneer. Although the technique of applying stone sheathing has changed remarkably little from that time to this, there has been a notable change in design and construction of the building frame itself. Where the Romans applied veneer to bearing wall construction, usually of massive brick and concrete, we apply it to a skeleton frame. The difference between sheathing the Pantheon on one hand, and the U. N. building on the other, are essentially those inherent in the difference in building frames. We have to deal with movement of the material itself as well as movement in the frame, and taken together these are among the most critical problems to be solved. Experiments are always being undertaken, and bonding patterns are as changeable in fashion as ladies' hats. The current efforts lean toward thinner and thinner veneers, less emphasis on fully bonded walls except where more permanent or monumental structures are involved, and attempts to combine thin stones with metal frames and panels.

Masonry construction has in the past solved exterior wall problems in a superior fashion because of its great strength, durability, resistance to weather and fire, dimensional stability, thermal transmission and its characteristic graceful weathering.

In view of current trends it may well be that beauty in old age will emerge as its most valuable quality. Strength itself is less important because stone is more likely to be supported than supporting. Fire resistance and thermal transmission may be less of a consideration under current pressures on codes to revise downward present fire resistant ratings for exterior walls. However, weathering and dimensional stability will be its prime attraction in any technical development likely to take place.

Contemporary design makes heavy demands for crisp, taut, clean surfaces. With proper selection of stone and correct detailing, masonry still affords the architect maximum assurance that a design will retain its original character for the life of the building.

PART THREE

Research and New Technical Developments

PRESIDING CHAIRMAN:

Howard T. Fisher
Howard T. Fisher & Associates, Inc.
Chicago, Ill.

MR. C. E. SILLING: Sometime during the confusion of 1) a Harvard education that included being a teacher, 2) acting as consultant to our Federal Government and the United Nations, 3) research on land use, housing and integrated building design, 4) practicing as an architect, 5) presiding over a music school board of trustees, and 6) associating with a variety of professional societies harboring consultants, architects, planners and others, your next session chairman found time to erect a personal corporate facade to cover his manifold activities. I am sure you are all aware of his solid professional accomplishments as an architect and a planner. Ladies and gentlemen, Mr. Howard T. Fisher, Howard T. Fisher & Associates, Inc., Chicago.

Thermal Performance of Clay Masonry Walls

C. B. Monk, Jr.
Structural Clay Products Research Foundation, Geneva, Ill.

Mr. Fisher: *Mr. Walker this morning made one statement that interested me especially and which I wrote down at the time. He said substantially as follows: "The joining of material is more important than the material itself." This is a statement of the very greatest importance in the construction industry, and not perhaps generally recognized by all of the manufacturers of materials and the architects, engineers who are concerned with design.*

Our first speaker this afternoon is Clarence Monk, manager of the Structural Clay Products Research Foundation's Architectural and Engineering Research Division. He is particularly concerned with this question of the joining of materials—not only how these materials join, but how these materials join other materials—how walls meet roofs how floors meet partitions, and so on.

Mr. Monk was an architectural engineer with the Armour Research Foundation of the Illinois Institute of Technology, and has been an instructor in the civil engineering department of that school and in the mechanical engineering department of the University of Illinois. He is a member of the American Society of Civil Engineers and the National Society of Professional Engineers.

In recent years designers of air conditioning systems have come to realize that predictions of heat loads based on the conventional calculations (using the "U" factor) gave higher design requirements than the completed buildings demanded. This experience plus both analytical and experimental findings have highlighted the importance of the influence of

density and specific heat of building materials on the thermal transmission into and within structures.

The usual way of making heat gain (or heat loss) calculations is to think of some fixed outside temperature, perhaps 95° to 105° F. The inside temperature is usually chosen from some control level, 70° to 80° F. The fixed temperature difference between the outside and inside temperature is the measure of the amount of air conditioning (or heating) needed as calculated from the k or U factor. The fallacy in these assumptions is thinking in terms of a constant outside temperature. The inside temperature may be constant; we like to have it so. But since the sun rises and sets every 24 hours, there is inevitably a rise and fall of outside air and building surface temperatures. This cycle in heat gains (or losses) is affected to a marked extent by the mass characteristics of the building materials (specific heat and density) as well as their thermal transmission coefficients. Recent field experience has shown that consideration of the thermal transmission coefficients alone is not a sufficient basis of calculation; specific heat and density are equally important.

Specific heat is the measure of the amount of heat required to raise a certain quantity of substance, we'll say a pound, one degree of temperature. Certainly it takes more heat to raise the temperature of one pound of water one degree than of one pound of aluminum.

Archaeologists tell us that primitive man soon learned that the continued warmth sustained in the stone he heated to cook his food was remarkably effective in keeping him warm over a period of time after the fire died out. In the modern age, the hot water bottle is familiar to all of us. This is a means of conveying heat by means of specific heat and density.

In climatology the influence of maritime bodies over continental land areas on temperature is well known. Cities near the Great Lakes area enjoy higher temperatures during the winter than cities in the central plains area at the same latitude. The reason is that the relatively higher specific heat of the water means that the water temperature never sinks to the same low level as the land masses.

Wall constructions having high heat storage capacity (i.e. high specific heat and density characteristics) will dampen the effect of the maximum rate of heat gain (or loss). As soon as the maximum outside surface wall temperature is reached, the surface begins to cool. As the outside wall continues to cool, the heat flow that has started on its way through the wall at the time the maximum surface temperature was reached will be split into a quantity that will flow out as well as in. This dampens the amount of heat finally reaching the inside surface. The greater the heat storage capacity the smaller will be the instantaneous rate of heat flow to the interior. Obviously this reduces the capacity size required of the cooling equipment.

What does this mean to human comfort? The dampening effect of wall mass will reduce the fluctuations of inside wall temperatures. People living in frame houses frequently experience the necessity of setting the thermostat higher to compensate for a rapidly moving cold front which suddenly engulfs the house. This sense of chilling is due to a sudden fluctuation in inside wall temperatures. Immediately radiant heat is lost from the human body to the wall.

Another matter that is of importance is that mass contributes to a lag in time of the heat progressing through the wall. For example, this may amount to six or eight hours for a relatively heavy masonry wall, before the heat which has accumulated during the day begins to reach the interior later in the evening. But in the meantime the external temperatures have dropped decidedly and you can then avail

yourself of nocturnal cooling by an attic fan. This has been a great benefit in Australia. Their people have employed this method to the fullest extent, almost eliminating the need for air conditioning systems in low-cost housing in that particular part of the globe.

In summary, theory and experimental facts to date show evidence that high heat storage influences thermal flow in the following ways.

1. Reduces the instantaneous rate of heat gain or loss. The initial size of the air conditioning or heating equipment may be reduced by as much as 25-50%.
2. Dampens variation of inside surface temperatures, thus contributing to greater comfort to the individual due to radiant exchange between him and his environment.
3. Delays the peak heat load reaching the interior (time lag) which allows the use of nocturnal cooling by attic fan for unconditioned space or of favorable electrical rates on air conditioners for conditioned space.

Theoretical Discussion

The factors that contribute to the magnitude and variation of surface wall temperatures are complex. Direct solar radiation plus radiation from the atmosphere and terrestrial objects are the initial sources of heat. The amount of this heat that goes into the outside wall surface is a function of the reflective characteristics of the surface. White or buff surfaces may reflect 40-60% of energy received, while dark colors may absorb as much as 90% and reflect only 10%. (The building surfaces themselves are sending out radiant energy to their total environment to further complicate the exchange.)

As a building is surrounded by air, temperature variation in the passing air masses plus the speed of air movement affect the convective transfer of heat into a building wall surface. Surface texture characteristics influence this phenomenon.

The combined effects of solar radiation, air temperature, and air velocity is frequently represented by the "Sol-Air Temperature" which is the equivalent temperature at the weather surface of the wall to give the same heat flow that actually takes place on to the surface due to the above causes. It is similar to (but by mathematical definition not exactly) the temperatures of the outside wall surface. Outside air temperatures may have daily variations ranging from 12 to 18 degrees on the east coast to 33 to 42 degrees in the Rocky Mountain area. It is important to note that the air temperature seldom exceeds a maximum of 100 to 110°F, whereas the Sol-Air temperature may have peaks ranging from 130 to 160°F depending on the wall surface. The daily variation in Sol-Air temperature may be 20°F on a north wall to 70°F for a west wall.

The flow of such a periodic heat cycle as described above through a building wall is dependent on the physical parameter:

Thermal diffusivity (α) $\alpha = \dfrac{k}{pC}$

Where k = coefficient of thermal transmission

p = density

C = specific heat

It is this physical property that is of significance in discussing periodic heat flow as opposed to k or U for steady heat transfer. Unfortunately mathematical expressions relating this property to heat flow are not in a form suitable for office computation. However the 1950 edition of the ASHAE Guide approximated the exact solution as follows:

$$q = U\ (t_m - t_i) + \lambda\ U\ (t_e - t_m)$$

Where q = max. rate of instantaneous heat gain

where t_m = average Sol-Air temperature

t_e = Sol-Air temperature at a time earlier by an amount equal to the time lag

t_i = average inside air temperature

ζ = a factor that depends on the wall thickness and orientation.

The time lag is the delay in the heat gain due to mass in passing through the wall. For 8″ of brick this is theoretically 5.5 hours; for 2″ of wood 1.3 hours. The two walls have about the same U factor, yet the theoretical maximum rate of heat gain is 60% greater through the wood for a west wall. The maximum heat gain would occur around 6:00 P.M. for the wood and 10:00 P.M. for the brick.

Exact theoretical solutions taking into account mass effects have been achieved analytically by thermal circuit analysis or experimentally by electrical or hydraulic analogies. These methods depend on the mathematical parallel between electrical or fluid flow and heat flow. These exact solutions substantiate the above approximation and emphasize the influence of the heat storage of interior walls in reducing peak loads.

Experimental Design

To determine with precision the influence of heat storage on the thermal performance of clay masonry, the Structural Clay Products Research Foundation undertook the experimental study of eight wall constructions: 6 clay masonry, 1 wood frame, and 1 metal panel (See Figure 1 for details). The technique of the experiment employed cubical huts (10′ x 10′ in plan). This permitted erecting 8′ x 8′ panels in each wall of the hut, oriented to the four points of the compass.

The purpose of adopting an experimental study on such a relatively large phenological scale was to obtain representativeness both as to the panel construction and workmanship and as to the statistical influences of weather patterns. Smaller specimens were held not to yield this effect. Prior to embarking on the program it was obvious that much fine theoretical work had been done in the field of periodic heat flow. However, for clay masonry, the projection of this theoretical work into practical results depended entirely on idealized mathematical assumptions and on existing laboratory determination of physical properties. It was felt that the combined influence of all variables subject to periodic weather patterns could best be studied by full scale huts. However elaborate the theory, it is no better than the experimental work on which it is based.

The use of thermal huts for experimental heat flow studies has been employed by several Commonwealth Experimental Stations. Scandinavian researchers have built them. In this country vapor transmission studies at Penn State and thermal circuit investigations at UCLA are known to have used thermal huts.

The methods of constructing the huts are shown in Figure 2. Each hut rests on a reinforced concrete slab. The walls are separated from each other at the corners by plywood columns filled with insulation. The walls were erected on a 12″ bed of rigid insulation (k = .34). The floors are covered with rigid insulation board (K=.25) to a depth of 9″. The ceilings are insulated with 10″ of loose fill insulation covered by reflective insulation. The attic space is vented and the roof surfaces are painted aluminum. The construction is designed to force the heat flow primarily through the wall panels. Figure 3 shows how access, *after the solid wall panels are in place*, is pro-

HEAT FLOW THROUGH MASONRY

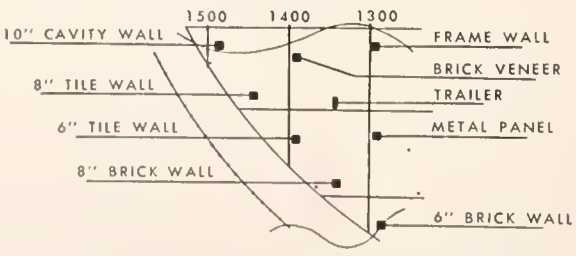


FIGURE 1—Plot plan of test site showing arrangements of thermal huts.

FIGURE 2—View of huts prior to installation of wall panels.

vided to the inside through a trap door in the roof.

Instrumentation includes thermocouples in each wall (16 in each face plus several addi-

FIGURE 3—Typical hut with access trap door open.

tional ones of interest within the wall). Three heat flow meters are placed on the inside of each wall (and eventually on the outside). Data from these instruments are recorded (see Figure 4) in an instrument shelter which houses a 144 point logger.

The temperature within the huts is maintained constant with the aid of 3 kw electric heating elements and a small ¾ ton air conditioner. A spiral type thermoregulator maintains temperature in the huts to within plus

FIGURE 4—Instrument shelter housing 144 point logger.

or minus 1°F. A record of the inside ambient air temperature is continuously obtained. The instrument shelter contains watt hour meters that measure total power consumption by each hut and flow meters that measure the total flow of water through the air conditioner. Thermopiles measure the temperature gradient in the air conditioning water. It is apparent from this instrumentation that the total heat flow into the huts may be checked against the heat removed. This has been done and found to balance within 3 to 6%.

Weather data obtained include outside ambient air temperature, wind speed, wind direction, amount of precipitation, and solar radiation. Provision exists to measure air conditioning condensate (latent heat) and humidity inside each hut.

An over-all view of the test installation is shown in Figure 5.

FIGURE 5—Complete test installation.

Test Results

Since the test project started in September of 1955, only data for the winter season are now available. The influence of heat capacity during the winter season has not been studied by theoretical analysts for it has been assumed that the range of daily temperature variation was greater in the summer than in the winter, the incident solar radiation is greater in summer than in winter, and the difference between inside and outside mean temperatures is much greater in the winter than the summer tending to mask the influence of the daily temperature range. Due to these considerations the conventional steady flow thermal properties were felt adequate for heating season calculations. Data presented below suggest a re-examination of this viewpoint.

Table I summarizes the experimentally obtained U_v factors determined under periodic thermal flow due to varying weather patterns. This factor represents the average heat loss through the walls of the thermal hut for the period of study per degree F temperature difference between average inside and outside ambient air (see Table I).

Four three-day periods have been chosen as typical results for mid-winter and early spring.

TABLE I

"U_V" Values Obtained from Thermal Hut Program

	Jan. 10-13	*Feb. 3-6*	U_S	*Mar. 9-12*	*Apr. 27-30*	U_S
Building #1 Brick Veneer (a)	.107	.092	.112	.094	.096	.112
Building #2 10″ Cavity (c)	.320	.297	.392	.321	.342	.392
Building #3 8″ Solid (b)	.536	.421	.491	.186	.183	.204
Building #4 "SCR brick" (b)	.597	.452	.678	.146	.162	.175
Building #5 8″ Tile (c)	.427	.339	.408	.375	.431	.408
Building #6 6″ Tile (c)	.507	.394	.423	.439	.537	.423
Building #7 Steel Panel (a)	.262	.189	.150	.250	.275	.150
Building #8 Wood Frame (a)	.131	.118	.110	.125	.129	.110
Max. Temp. °F	38	41		59	78	
Min. Temp. °F	28	10		21	36	
Average Wind Vel.	15 MPH	6 MPH		14 MPH	14 MPH	
% Possible Sun	0-0-100	100-99-76		100-70-68	25-0-0	
Precipitation	Trace	None		Trace	2.38″ Rain	

(a) Wall construction includes interior finish and insulation #1, #7, #8
(b) Interior finish and insulation added between Feb. 7 and Mar. 8, #3, #4
(c) Exposed masonry on interior #2, #5, #6

A variety of weather patterns is represented. The period from Jan. 10-13 represents as near a steady state as was obtained during the period of record: even here a 10°F range was experienced. Feb. 3-6 was a period of high temperature range, low wind speeds, and large percent possible sunshine; therefore, cyclic influences should be most pronounced during this period. The period April 27-30 included mostly overcast skies with considerable rain.

The U_s factors are those calculated from the ASHAE Guide for steady state condition. The one exception is the metal panel which value was obtained from the manufacturer who reported the results of laboratory tests on wall sections including through-the-wall metal ties.

The construction will not be described in detail here, but suffice it to say that the clay masonry walls were all composed of red clay units, lightly textured. The wall finishes used consisted of conventional furring, blanket insulation, and dry wall techniques. The wood frame hut was covered with white ship-lap siding. The metal panel was a typical industrial type containing 1½″ of Fiberglas insulation with a metal sheet interior finish. The metal surface being galvanized was left unpainted; this surface has darkened with age.

Generally speaking, there is a marked difference between the U_s and U_v values. The frame and metal huts have U_v values above U_s; the clay masonry huts have values below. While differences in color do have an effect, it should be noted that the frame was white and the metal was darkened galvanized, each representing radiation extremes on both sides of the red brick color; yet both of these constructions having small mass showed heat losses greater under periodic heat flow than predicted from steady state knowledge (10-20% for frame and 30-60% for metal). The clay masonry displayed U_v values that were 0-20% below the U_s values with a trend to smaller differences occurring with the hollow units and larger differences with the solid units.

A comparison between the brick veneer and frame is of interest since these two constructions had nearly identical U_s factors. Yet the veneer experienced heat losses roughly 10% less than calculated, whereas the frame showed 15% more. These two constructions were nearly identical except the outside covering being 4″ of red brick in the one and 1″ of white wood siding in the other. The table below shows for the Feb. 3-6 period the daily U_v values for the north and south walls of the two huts.

	Brick Veneer	*Wood Frame*
U_s	.112	.110
U_v North Wall		
2/3	.118	.135
2/4	.119	.148
2/5	.128	.131
U_v South Wall		
2/3	.069	.096
2/4	.067	.113
2/5	.063	.089

These data, typical of other periods, show that even on the north wall (where color differences are minimized) the veneer values are much less than the frame values. The low U_v values of the south wall are due to the solar radiation received during the day. The data also point out the difficulty of choosing an arbitrary U factor to be representative of both orientation and periodic effects. Those designs based on U factors carried to the third decimal place suggest an accuracy not warranted.

A comparison between the "SCR brick" (a 6″ through-the-wall clay unit) and the metal huts is worth noting. The insulated values of these walls are roughly the same (.175 and .150, respectively). The U_v for the "SCR brick" is on the average 15% under the U_s value whereas the U_v for the metal is about 50% above. *On this basis, if the two walls had*

identical U factors, 55% more heat would be lost through the metal panel than the "SCR brick." Presumably these differences are due to mass. The experimental determination of U_s for the metal panel is reported to have taken into account through-the-wall ties. The darkened metal surface should have had the advantage in receiving solar radiation to reduce heat loss.

Though not studied in as much detail as the U factors above, the maximum rates of heat loss shown for the brick veneer and frame during the Feb. 3-6 period are:

	Brick Veneer btu/hr.	*Wood Frame btu/hr.*
North Wall		
2/3	500	600
2/4	450	500
2/5	400	350
South Wall		
2/3	400	600
2/4	350	500
2/5	300	350

Thus the demands on the capacity of the heating source were 20% less in the case of the brick veneer.

Summary

The results obtained thus far in the thermal hut program were primarily for the winter season. Contrary to orthodox assumption, periodic heat flow was shown to have a significant influence on heat losses. Under the periodic heat flow of actual winter weather patterns wall constructions having low mass, such as frame and metal panels, were shown to have total heat losses significantly greater than from steady state calculations (ranging from 10-20% for the frame and from 30-40% for the metal). For walls having high mass, such as clay masonry, the total heat losses were less than from a steady state calculation (ranging from 0-20%). The precise extent to which mass (both density and specific heat) affect this result may await future detailed study of all the physical parameters concerned.

Ceramic Veneer Panelizing

Albert E. Barnes
Gladding, McBean & Company
San Francisco, Calif.

Mr. Fisher: *One of the fine things about these Building Research Institute Conferences of this kind is that a wide variety of viewpoints is represented. In contrast to the viewpoint of Mr. Monk for the engineers, we have an industrial viewpoint expressed by Mr. Barnes who will speak on ceramic veneer panelizing.*

In addition to his 29-year connection with Gladding, McBean & Company as manager of architectural products promotion, Albert E. Barnes is also Secretary of the Architectural Terra Cotta Institute, a past president of the Southern California Chapter of the Producers Council, and a member of the Construction Specifications Institute.

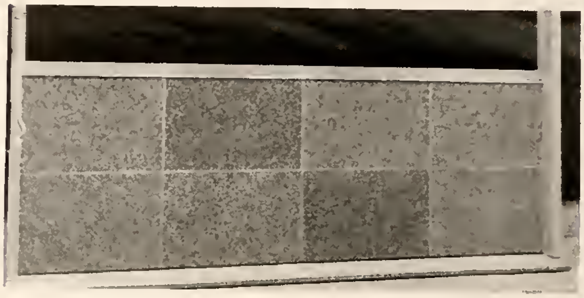
Every alert member of the building industry has, I am sure, noted with great interest the trend in recent months toward the extensive use of curtain wall construction. It has become so well known and so widely used that no definition at this time is required. Member manufacturers of the Architectural Terra Cotta Institute have noted this trend and recognize the obvious merits of curtain wall construction.

As has so often been pointed out, curtain wall design eliminates the need of a back-up wall, thereby reducing the required wall thickness and reducing the weight of the exterior wall. As a matter of fact, there has been a trend toward thinner masonry curtain walls for a number of years and some of the largest and finest recent buildings on the Pacific Coast have had exterior masonry non-load bearing walls of 8″ thickness rather than the

thickness of 12", 17" or 19" so often referred to in comparisons of thinner curtain wall construction. This reflects a saving, both as to installation time involved and as to cost. The obvious objective of curtain wall construction is the ultimate reduction of thickness and of in-the-wall cost.

Ceramic veneer manufacturers have, for several years, discussed this problem and actual research and production of test panels has been in progress for more than two years. ceramic veneer panelizing, as it is known today, is the development of a precast ceramic veneer curtain wall panel which is cast and cured under ideal shop conditions and then delivered to the job and attached in place on the building by bolted or welded connections. Members of the ATCI have adopted the trademark name "CV Panelwall," The Prefabricated Ceramic Veneer Curtainwall. This development is most significant in that for the first time in the building industry, the time proven advantages of high-fired glazed masonry facing material are now made available for curtain wall construction.

Our discussion today will include two general types of panels which are known as CV Panelwall. We will refer to the first as a *curtain wall panel*, which is fabricated with lightweight aggregate concrete backing, is approximately 3" to 5" in thickness depending upon fire resistance requirements, and is available in units up to approximately 30 sq. ft. This panel was designed for and is now installed on the Methodist Hospital in Arcadia, California. In fact, it is because of an urgent request by the architects, Neptune and Thomas of Pasadena, for a method of using ceramic veneer in curtain wall construction that we accelerated our activities in developing this panel. We are indebted to them for their continued interest and cooperation during the design and fabrication of our curtain wall panel for this project which is now being constructed by the Ford J. Twaits Co. of Los Angeles. We have also developed a thinner, lighter weight panel, approximately 1½" to 1¾" in thickness which is designed for use in *window wall* construction.



PRECAST CERAMIC VENEER SPANDREL PANEL

Development of CV Panelwall

The development of ceramic veneer panels involved the adaptation of well known and thoroughly proven techniques of lightweight precast masonry construction. The problem consisted of developing a satisfactory technique for placing ceramic veneer (architectural terra cotta) facing units in a form and casting a reinforced lightweight concrete backup that would produce a panel of required thickness and strength in order to handle the panel during the curing, delivery and erection and to provide the proper resistance to wind pressure and seismic forces when the panel is installed in the structure; also, to provide a panel that is impervious and that will remain so during the life of the structure. In this respect, attention is called to the proven characteristics of good masonry construction as to permanent water resistant qualities and low maintenance cost.

The ceramic veneer facing unit is approximately 1" thick and is a de-aired, extruded, precisely finished clay body with a high-fired impervious glazed finish. The lightweight aggregate used in the concrete back-up is an expanded shale type such as Basalite, Rocklite, Haydite, etc., and was chosen to obtain concrete of lightest weight and greatest strength.

METHODIST HOSPITAL, ARCADIA, CALIF. Four-story elevation showing installation of 9′0″ panels and 4′6″ panels.

Vermiculite concrete is added to the panel to provide the required fire resistance or additional insulation when specified. The reinforcing steel used is a heavy galvanized welded steel mesh or reinforcing bars or light channels may be used to provide the proper reinforcing.

Physical Properties of CV Panelwall

After several years of research, it has been determined that a *thickness* of 1″ of ceramic veneer facing with a backing of 2″ of reinforced lightweight concrete, in which reinforcing steel has been incorporated, provides the required strength for this type of panel. Work is now proceeding on the development of a much thinner panel, approximately 1¾″, for use in window wall construction in which channel steel is incorporated in the reinforcing design in order to furnish satisfactory tensile strength requirements in the ¾″ thickness of concrete—this thinner panel is being developed to be used in aluminum or steel window wall construction.

There is a permanent *bond* between the ceramic veneer facing and the concrete backing. This is assured by thoroughly dampening the CV units, applying a brushed-on bond coat of neat portland cement and making sure that the low water-cement ratio concrete is effectively vibrated for maximum density and bond.

The *fire resistance* of the basic 3″ panel is one and one half hours, according to recent tests at the Ohio State University Research Laboratory. However, a higher fire rating may be obtained, when required, by the addition of vermiculite concrete or other rated insulating material. Also, a precast CV *mullion* has been developed and can be furnished where fire rating requirements indicate the advantage of a masonry mullion.

The excellent weather resistant qualities of ceramic veneer are assured by the high-fired

METHODIST HOSPITAL, ARCADIA, CALIF.

Cement mortar bed is prepared and Koroseal gasket placed.

Toggle bolts placed through strap anchors into holes in mullions.

Fiber gasket and metal shims placed for accurate adjustment.

impervious glazed finish. In casting the CV panel, joint strips ½″ deep are used which are later removed so that the finished panel can be pointed with a dense pointing mortar and tooled to provide proven water repellent qualities. Since the thermal coefficient of expansion of the CV Panelwall is considerably less than metal, minimum temperature movement is assured and the methods used in casting produce a monolithic watertight panel with no voids in which condensation or other moisture can collect.

Since there are *no through-wall joints* in the panel itself, the only seal required to prevent infiltration or rain penetration is around the perimeter of the panel where it adjoins a metal mullion or other element of the building structure. These joints are designed of polyvinyl chloride plastic. Because of the minimum temperature movement mentioned above, the adjusted compression against the polyvinyl gasket remains well within the modulus of elasticity of the material. This provides a permanent joint seal.

As far as the thermal conductivity of the CV Panelwall is concerned, it is to be noted that in addition to the basic U factor of the masonry panel, depending upon the thickness and back-up material to be used, the panel has the additional benefit of heat lag, the recognized heat capacity of a masonry wall when intermittent heat loads, such as the hot afternoon sun, are the main consideration. A lower U factor is easily obtained by additional insulation which may be applied to the panel at the time of casting or to the interior surface of the wall after installation.

In the case of the Arcadia Hospital, on which this panel is now installed, a satisfactory U factor to meet rigid air conditioning requirements was obtained by adding 1″ of vermiculite plaster to the back of the spandrel wall after installation. This insulation covered the metal mullions as well as the masonry panel, thereby eliminating any through-wall metal connection. Attention is called to the fact that masonry panels which have no through-wall metal surround have a more consistent insulating value than any type of panel that involves a metal perimeter frame and through-wall metal connections.

Fabrication of CV Panelwall

No particular problem or unforeseen difficulty was encountered in casting the panels; the casting was accomplished by men well experienced in precasting concrete units.

In regard to *anchoring connections* on the panels for the Methodist Hospital, strap anchors were attached to the panel reinforcing

mesh and embedded in the concrete backing; these were shaped to project at the ends of the panels for attachment to the back of the aluminum mullions. The panels were then set on the concrete floor slab in a cement mortar bed and were bolted to the back of the aluminum mullions by toggle bolts through the projecting strap anchors. A fiber gasket was used for insulation between steel and aluminum. Metal shims were also used to assure proper compression of the polyvinyl gaskets against the aluminum mullion angles.

It is possible to embed anchor points in a lightweight concrete panel to meet the requirements of any anchoring system which the architect or engineer may design. Recently, we have developed details to show proper anchoring for a panel set on the face of a building, supported by anchor clips to a steel or concrete frame. For window wall construction, no difficulty is foreseen in inserting a panel of proper thickness into a surrounding metal frame; this has been demonstrated in our research laboratory and plans are now being prepared for its use on a west coast office building.

Installation of CV Panelwall

Techniques of installing precast concrete panels are well known to most contractors. The Arcadia Hospital panels, concrete with CV facing, were delivered to the job on large wooden easels and unloaded by fork lift trucks. Handling of the panels was facilitated by threaded inserts which were welded to the reinforcing mesh and into which steel eye-bolts were screwed to provide lifting points. The panels were then lifted into place in this 4-story building by means of standard rigging equipment. No serious problems were experienced in handling the panels and the installation was accomplished by a masonry contractor in less time than originally anticipated.

Attention is called to the flexibility of CV Panelwall. Having proven the practicability of the precast masonry panel and having developed both the curtain wall panel and a panel for thinner window wall construction, it is apparent that the design possibilities of the panel are quite flexible and may be adapted to practically any type of construction by means of proper anchoring details. The curtain wall panel serves its best purpose as a masonry curtain wall incorporated in lift-slab, steel-frame or reinforced concrete frame construction, and can readily be finished with low cost continuous interior surface materials.

Comparative Data of CV Panelwall

In considering *cost*, the flexibility of the CV panel design and proven economies of masonry construction will assure over-all economy when the building is designed for this type of construction. Based on our present experience, we believe that a CV panel can be cast and placed in the wall for very little more than the present cost of installing only the ceramic veneer facing by the hand-set method; thereby saving a large percentage of the cost of the back-up wall. Obviously, the size of the job, type of building, anchoring design, etc. will affect the in-the-wall cost. It is estimated, however, that the cost of the curtain wall panel will compare favorably with prices now being quoted on better grade, insulated panels of other materials. In making any comparison of cost, it is necessary to list all costs of preparation, provision for proper anchoring, etc.

Weight-saving is important in presentday construction. CV Panelwall, in the 3″ curtain wall thickness, weighs approximately 30 lbs. per sq. ft. This is most significant when you consider that handmade architectural terra cotta, approximately 4″ thick backed up with 8″ of masonry, weighs approximately 125 lbs. per sq. ft. Present day 1″ thick adhesion-type ceramic veneer backed up with 6″ of lightweight aggregate concrete—a total thickness of approximately 8″—weighs about 70 lbs. per sq. ft. The weight of the CV Panelwall, which is approximately 30 lbs. per sq. ft., is less

than ¼ of the weight of a 12″ masonry wall with which competitive panels are so often compared. Test panels indicate that a thin CV Panelwall for use in window wall construction will weigh from 15 to 18 lbs. per sq. ft.

Since weight is an important factor affecting the *sound transmission* of walls, it is apparent that the use of CV Panelwall, where through-wall metal connections are eliminated, will provide much lower sound transmission than other types of panel construction.

In regard to *color*, the outstanding proven advantage of CV Panelwall is the high-fired, impervious glazed surface, available in practically an unlimited choice of shades of color and finishes that will not fade under the brightest sunshine and that are impervious to the action of corrosive atmospheres, thereby assuring permanent beauty and low maintenance costs.

Regarding the *space saving* qualities of our curtainwall panel, this panel reduces the required thickness for a ceramic veneer faced wall from 8″, which includes 6″ concrete backup plus 1¾″ of ceramic veneer and mortar setting bed, to 3″, plus whatever additional insulation or fire proofing may be required. The CV Panelwall for window wall construction is approximately 1¾″ thick. The Structural Clay Products Research Foundation is actively engaged in a research program to improve the ceramic veneer panel construction and to assist in developing thinner and lighter panels.

Distribution and Marketing of CV Panelwall

CV Panelwall is a development of the Architectural Terra Cotta Institute, which includes manufacturers of ceramic veneer (architectural terra cotta) throughout the United States. Continued research and development work on the panel is being done by the Structural Clay Products Research Foundation and with their advice and help, member companies are developing curtain wall panels and fastening details to fit the requirements of projects in various parts of the country.

CV Panelwall construction is available through member companies of the ATCI who are now prepared to discuss the possibilities of this development with architects and engineers in any part of the United States and whose policy it will be to see that such panels are properly designed, fabricated and installed so that a satisfactory result is assured.

Advances in Uses of Natural Stone

J. T. McKnight

Indiana Limestone Institute, Bedford, Ind.

MR. FISHER: *The scope of this conference is modern masonry—natural stone and clay products. We heard something on the clay products and now we will hear two speakers on recent advances in research on natural stone.*

Mr. J. T. McKnight is the Executive Vice President of the Indiana Limestone Institute. He began his work there as a field engineer. He has been associated with a number of companies in the Indiana and Texas limestone industries and has a specialist's education in construction and administration.

NATURAL building stone, which has been employed for human habitation in all periods since the beginning of recorded history, is still the predominant facing medium for many of our finest structures designed by architects today.

The method of quarrying stone, its fabrication, its design, and its installation have, of course, varied widely with architectural standards employed at the time.

In recent years, because of the rising cost of construction, architects have concentrated on radically simple design compared with the typical architecture of yesterday. A prerequisite of this simple design has been the desire to use thinner and lighter walls. Our substantially accelerated research program has joined in this search.

We have directed our research thinking to a varied application of thin walls, using stone

as a facing, supplemented and coordinated with accepted installation media in individual complement or in packaged arrangement.

The steps we have taken in the Institute development program are the result of immediate demand. They represent only a beginning. We will continue to improve all our projects. We also intend to increase our breadth of imagination and our usefulness to the architect who strives to design buildings which are not only different but better.

Many of the projects we will discuss here have been developed by our engineers and researchers and will, for the most part, employ Indiana limestone. Many of these projects, however, are adaptable or applicable to other natural limestones, such as Texas, Alabama, Minnesota and Kansas.

I would like to take just a moment to explain Random Ashlar or Rubble Veneer. There seems to be a need for clarification of the use of this material for producing and applying to the building.

Random Ashlar differs a little from rubble stone, as you have exact sizes in heights, running 2¼", 5" and 7¾", and with a ½" mortar joint, can be coordinated with brick for design purposes. You will find the Random Ashlar type of stone more prevalent in limestones, such as Indiana, Alabama, Texas, Kansas and Minnesota. These stones permit the quarrying of large size blocks and through the process of sawing can make the regular course heights.

Random Ashlar is shipped to the job site in promiscuous lengths which provides an opportunity for the mason to set it in a practical and economical manner, as he can break the stones to lengths required at the job site very easily with a masonry saw.

Rubble stone, often referred to as "Native Stone" because it can be found in practically every state in the Union, is also shipped in promiscuous lengths, but does not have standard course heights. This type of stone permits an even more random, or rustic effect. The Rubble stone is usually found in a variety of colors, ranging from white to a dark pink or red.

Until recently, it was necessary to handle random stones in individual pieces, which was very time consuming and expensive to the producer and consumer. This type of stone is now bundled with metal bands with a ton of stone to each bundle. The loading and unloading problems have been minimized by palletizing to the point where it is very advantageous to both the producer and the consumer.

Random Ashlar and Rubble stones have increased in popularity because of the demand in the residential construction field for a material with durability and beauty which is maintenance-free. For the most part, Random Ashlar or Rubble stones are confined to residential construction. They are also adaptable to commercial or religious type buildings, however, when used with a cut stone trim which provides a very pleasing contrast in color and texture.

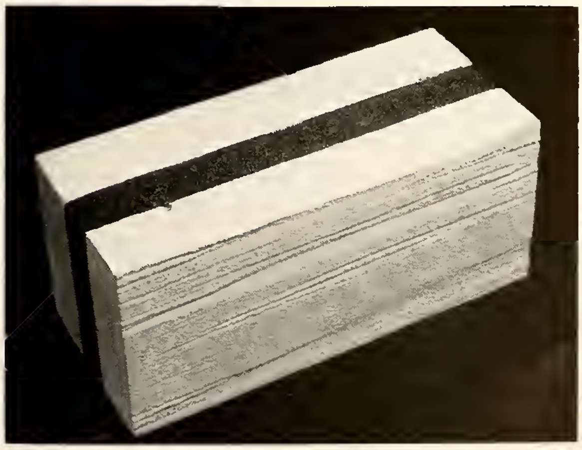
Because of the popularity of these products the Institute research department has given high priority to the development of a thru-wall unit. We specified that the exterior of this complete unit was to be stone resembling Random Ashlar. What resulted is a thru-wall unit using 3" of stone as the exterior, 2" of a rigid type insulation, such as foam glass, and 3" of natural stone aggregate which serves as the interior and can be painted or plastered. The aggregate made from natural stone waste can be permanently color stained when cast.

The thru-wall unit has a very good insulating quality, taking advantage of the insulating material. It gives an average U factor of .12. The unit has been designed for ease in handling and will be principally 5" high and 24" long, although this is not a strict limitation,

HOME IN INDIANAPOLIS, IND., BUILT WITH INDIANA LIMESTONE. FRANK HOCHMILLER, ARCHITECT

as it could easily be 30″ long. But, in general, we have found that the lighter the unit, the quicker its acceptance by builders. The thru-wall unit will provide the builder with a construction material which is beautiful, has insulating value, is maintenance free and fireproof, and has a very low per square foot cost.

The cost in the wall will vary, of course, with freight rates, setting costs and other factors involved. But we do know from surveying the market that the thru-wall unit is lower in cost than many competitive materials.



LIMESTONE "THRU-WALL UNIT"

There is another application of stone serving both as the exterior and interior for trim work around windows. It was developed to be used with either the thru-wall unit or for acceptance in the prefabrication field. This application is for window surrounds, using a smooth finish stone, 1″ thick with 3″ of insulating board and a sprayed-on aggregate which serves as the interior. The interior surface can be painted or plastered.

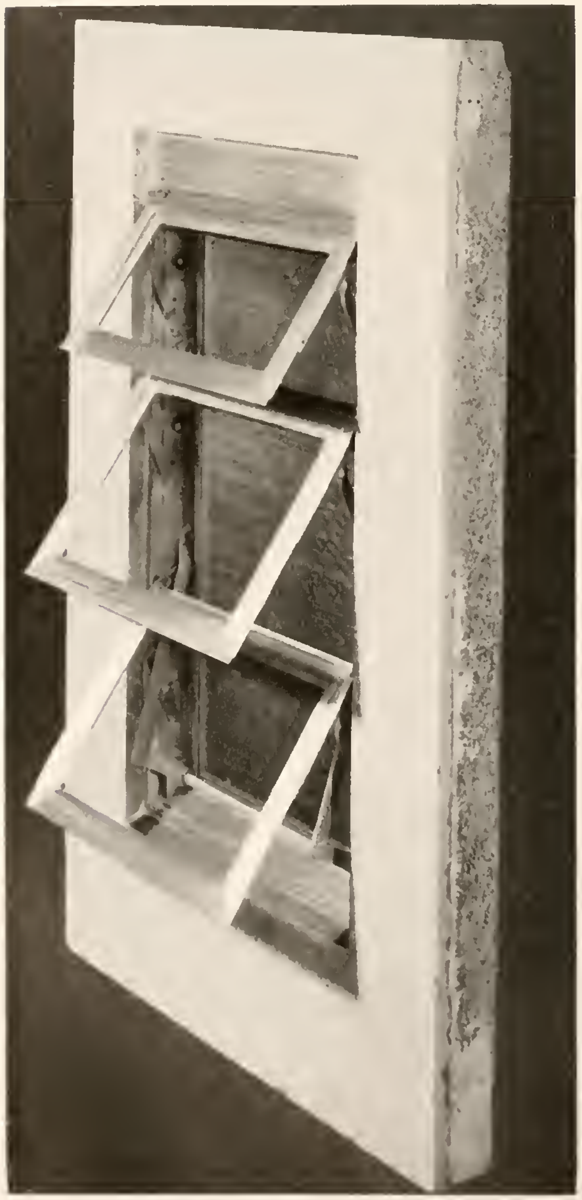
LIMESTONE WINDOW SURROUND

The stone, insulation and interior finish surround the window frame in any size desired. In other words, it permits the placement in the building of the window frame, stone trim and interior as one unit. We believe this will permit our entry into the prefabrication field which is becoming more and more popular.

On the two above-mentioned projects, I have referred to rigid-type insulation. There are a number of rigid-type insulating materials which can be used, including foam glass as

manufactured by Pittsburgh Corning Corporation, or Tectum, as manufactured by Tectum Corporation of Newark, Ohio. These are the materials we have worked with in our laboratories and which have proven successful although there may be equals.

As you all know, the application of waterproofing materials on masonry has become very popular in the last few years. For the most part, these materials have been misused, because they have been applied to prevent staining or discoloration rather than for their purpose, which is to increase the flow of water from the surface of walls. At least that has been the experience of the Institute field engineers. You are all acquainted with the problems of construction and know the situation that can be created by water getting into the wall during the period of construction.

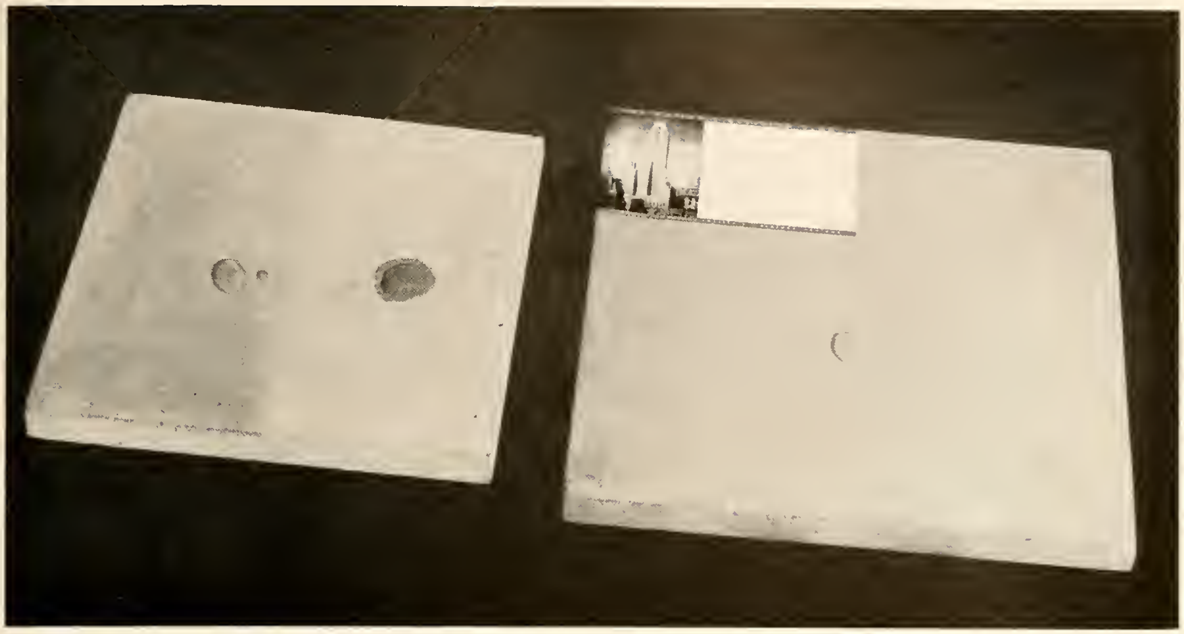


LIMESTONE WINDOW SURROUND

Natural stone is often blamed for discoloring and staining when actually the material is not at fault. Natural stones, for the most part, do not have any staining qualities in their physical or chemical makeup. Staining occurs when water has been permitted to get into the wall cavity and carry soluble salts or alkali from the back-up materials through the stone to the surface by capillary attraction. Staining can be prevented with proper precautions but, of course, we have no control over the elements of weather.

The problems of staining and discoloration on natural stone are now being solved through the application of waterproofing material manufactured for use on limestones only. For instance, the Institute has developed a waterproofing material which takes advantage of the very chemistry within Indiana Limestone. This waterproofing material which is adaptable only to Indiana Limestone will not discolor the stone after application as will some of the commercial products. From all laboratory tests we have found that all indications point to a more lasting or durable waterproofing than some now found on the market, yet it does retard absorption of water and permits a free flow from the surface of the material.

We know that other natural stone producers are working on the same project. The Institute's waterproofing material will be released and marketed in the near future for application on Indiana Limestone. As indicated, from all tests and laboratory data, we believe this will



THE SAMPLE OF LIMESTONE ON THE RIGHT SIDE SHOWS THE EFFECTIVENESS OF THE WATERPROOFING MATERIAL DEVELOPED BY THE INDIANA LIMESTONE INSTITUTE

reduce our problems of staining and discoloration by 90 per cent.

More and more simplicity in design seems to be the keynote of modern building, and along with this has gone the reduction of wall weight and a trend towards thinner walls. In keeping with this trend, the Institute has first designed a masonry wall using a thin veneer stone 3″ thick, backed up with a rigid-type insulation. The thickness of the wall was reduced yet the structural and insulating qualities were maintained. This thin veneer used with an insulating material was first employed in the Labor-Industry Building at Harrisburg, Pa. On this building, foam glass was applied to the back of the stone to maintain insulating qualities. Our experience was very satisfactory on the Labor-Industry Building and as a result that type of wall design has been used in other buildings throughout the United States. This was one of our first steps toward reducing wall weight in conjunction with the popular curtain wall design.

LIMESTONE THIN WALL PANEL

The next step towards reducing wall weight was the development of a panel using a number of pieces of stone applied to a single piece of rigid-type insulating board by mechanical fasteners. This type panel is now being used in the Meadows Shopping Center in Indianapolis, Indiana. The panel used on this project was 10′ long, 30″ wide. This, however, is not a limitation in size. Aside from the panels being used in the project, they were tested in the mills and handled in a very destructive manner

in an attempt to break the stone from the insulating board.

The panel provides an opportunity to make use of several stones economical to fabricate in size, but which, when applied to the insulating board, can be hoisted into the wall as one unit, permitting an increased square foot coverage at the end of the work day. Our experience to date has been that masons, although they were not acquainted with the use of the panels, have been able to set over 1,000 square feet per working day. The insulating value of this panel, using 2″ of stone and 2″ of Tectum is .18, or the equivalent of 5 feet of solid concrete in insulating value.

The pieces of stone are applied by mechanical fasteners. The panel is then anchored to the building with strap anchors and dowels. For the most part, the panel is attached to the wall in much the same manner as stone is commonly applied. Details and specifications on this panel will be released in a very short time and made available to architects and builders.

I have spoken at different times about contrast in color and texture. I know that you are all acquainted with the demand for color and how it is being used very attractively by the architect in light and dark shades. The Institute has developed a penetrating stain which can be applied to a natural stone without destroying the natural texture or appearance. This coloring process is not a paint, but a penetrating stain which is applied with special equipment. From all tests made in independent laboratories we can state that the colors will last 15 years and probably longer.

Standards and specifications are being prepared for this penetrating stain using basic colors at this time. Through the use of this penetrating stain we can provide the architect and consumer with a colored product with durability and all the advantages of natural stone. We anticipate that this colored stone will be used for the most part as a contrast with the color of natural stone, which is usually lighter.

For instance, a building is now under construction using a standard buff ashlar field, which is a light warm color, with dark gray Indiana Limestone with the penetrating stain applied for window surrounds and entrance features. This penetrating stain is another new product which will be prepared and distributed in a very short time.

As I indicated at the outset of this presentation, I have been talking about developments in the Indiana Limestone Industry for the most part. It is only because I am most familiar with this program, having been associated with the Institute for several years. However, I know that great strides have been made by the other natural stone producers and they, too, will provide the architect and building owner with new designs and new applications. These projects undertaken by the natural stone industry have been designed to provide the architect with new and modern applications of stone that can potentially be used for some of the low-cost building programs, such as schools and residences; but also it can be used in practically every elements of the construction industry, including commercial and religious buildings.

In conclusion, let me say that the natural stone industry is making every effort to provide the construction industry with new, more efficient, and less expensive applications of natural stone. We believe architects and building owners who use masonry and natural stone have something both new and exciting to look forward to in the future.

Marble and Granite Research

A. T. Howe

Vermont Marble Company, Proctor, Vt.

MR. FISHER: *Our next speaker is Vice President and General Sales Manager of the Vermont Marble Company—Mr. A. T. Howe. I understand Mr. Howe started in the marble business 47 years ago as a young man when he carried water that was thrown over the slabs of marble for their grading.*

Mr. Howe has a very long career and intimate contact with this great industry in our field.

MY subject is "Marble and Granite Research," but as I speak in this instance for the Marble Institute of America, I may easily omit reference to granite. Please understand that in many instances what is stated about marble could also apply to granite.

Marble is one of the oldest known materials for use in monuments and buildings, for it was used long before the birth of Christ, and its use continued on down through the ages. It is old, yet it is ever new.

On the other hand the word "research" has become associated in the minds of many people only with new products and materials. In my book that is only one kind of research. To us in the marble industry, research means not only finding new applications for an ancient material, but discovering in the shop, in the

laboratory, and in the field, new methods of manufacture, new means of installation, and new ways in which to make the architect and builder constantly and actively aware of marbles in their modern dress. I have with me today several illustrations of what is being done throughout the country with marble; activities which prove that marble is maintaining its pre-eminence in the building field.

I shall say nothing regarding beauty, character, infinity of color, durability, and easy and low cost of maintenance of marble, nor shall I discuss the beautiful buildings of yesterday (and for that matter, of the day before yesterday) which have employed marble with such high standards of taste and design, some of which we see around us today.

Modern architecture, the architecture of tomorrow, has been called many things, both good and bad. I want to go on record here and now to say that I think much of it is good. I don't mean, of course, that every building erected today or from now on will be a work of art, but, generally speaking, that concept of architecture which sets up a strong, slender, steel frame on which are hung floors, walls, and all elements of the building, cannot be ignored. We in the masonry industry must adapt ourselves to the spirit of this type of architecture, and we are so doing.

The stimulation which only classic materials can inspire, plus research, will give the architect, the contractor, and the owner that which is desired. The direction of our research was stimulated by new architectural design and its demand for thin and lightweight walls. Our research takes into consideration the preparation of units which can be installed more economically.

Basically, the new architectural design is aimed at reduction in the cost of material and its installation.

I would like to show you some illustrations of the results of our past research and some of the things we are working on now for the future.

FIGURE 1. State Office Building, Pittsburgh, Pa., financed by the General State Authority, now nearing completion.

Figure 1 is a progress photograph of the Pennsylvania State Office Building which was financed and built by the General State Authority in Pittsburgh, Pennsylvania. It represents a good example of veneer application of marble. The 1¼″ thin slabs of marble are securely anchored into the masonry back-up which progressed at the same time. This is typical, of course, of the practice of veneering. Veneering of marble is excellent practice in modern construction and plays an important role in the modernization of older buildings as well.

Figure 2 shows the exterior of the National Headquarters Building, International Brotherhood of Teamsters. Here is another fine example of the marble veneer wall with masonry back-up. It is, as you can see, a new building. Those of you who know Washington, D. C., will easily recognize it.

Figure 3, the Equitable Life Building in San Francisco, California, is yet another modern example of marble veneer construction.

The method of applying marble veneer is a familiar one. Specifications for it are set forth in a booklet called "American Standard Specifi-

cations for the Support, Anchorage and Protection of Exterior Marble Veneer 2″ and Less in Thickness and Exterior Marble Used in Curtain or Panel Walls." In spite of the length of the title, the specifications themselves, while thorough, are contained in just a few pages. You will be interested to learn that the latest edition of the book has already been widely distributed to architectural offices throughout the land. It is available from the office of the Marble Institute of America, Mount Vernon, New York, to any who request it.

Veneer construction, a product of research, was developed to meet the demands of modern architectural design for a thin, lightweight wall, and there are many more examples of marble used in this manner in all our major cities.

Industry research has gone on to meet even more rigid demands for thinner walls and preassembled units—the curtain wall. The same architectural desires which brought about the veneer application, which can be defined as a covering for masonry construction, now have gone farther and demand a wall that is not only a covering but a complete through-the-

FIGURE 3. The Equitable Life Building, San Francisco, California, illustrating the use of 2″ marble veneer construction.

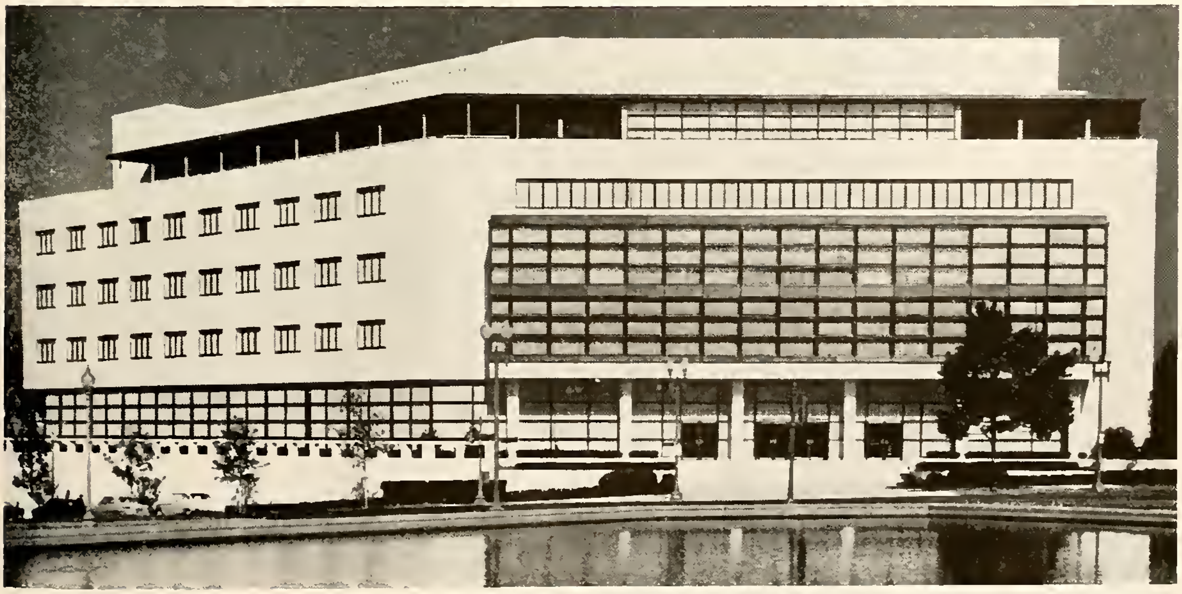


FIGURE 2. National Headquarters Building, International Brotherhood of Teamsters, Washington, D. C., another example of marble veneer construction.

FIGURE 4. West Columbia Elementary School, West Columbia, Texas. Marble slabs were used above as well as below all windows.

FIGURE 5. West Columbia Elementary School, West Columbia, Texas. The ⅞″ marble slab being tilted into place constitutes the entire thickness of the wall.

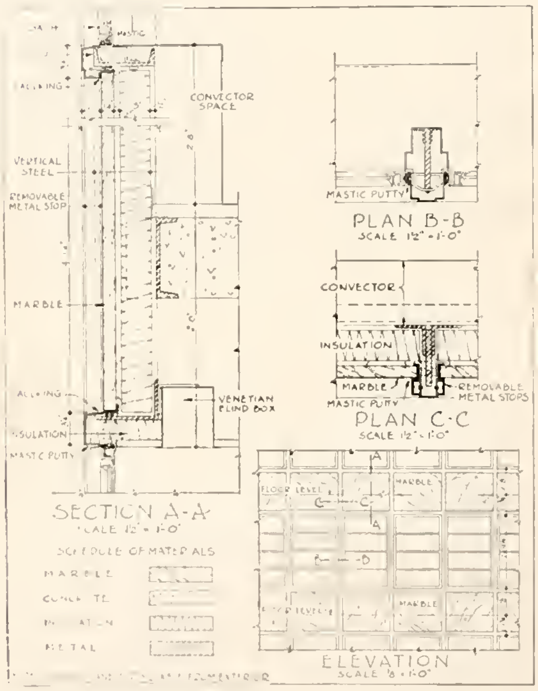


FIGURE 6. Detail Plate No. F from Marble Institute of America's Standard Specifications For the Support, Anchorage and Protection of Exterior Marble Veneer Two Inches and Less in Thickness and Exterior Marble Used in Curtain or Panel Walls.

FIGURE 7. Gulf Oil Corporation Building, Atlanta, Ga. Exterior marble being set into place from the inside of the building.

wall unit. It was required that this unit include insulation equivalent to masonry back-up, and even an interior finish, installed in framing or without it. Our research is geared to the fulfillment of these desires but with the realization that heavy, cubic construction and veneer treatments over masonry will always have a place on monumental and enduring structures.

What has been accomplished by research in these newest concepts of architectural design? What problems were faced in providing economical curtain walls? There were, of course, many problems, but I should like to say here that one problem we did not have to face was the performance of the marble itself. Whether ⅞" in thickness or thinner, or seven feet thick, marble still retains its dimensional stability, its characteristic beauty, its durability, its luxurious appearance, its economy and low maintenance.

We will not go deeply into all the details of the problem. Their enumeration, however, would give an indication of the extent of our energies to accomplish the objective. Rather let us examine several more photographs which show typical curtain walls of marble or construction details that speak for themselves.

As the first photograph, (Figure 4), it would seem appropriate to show the simplest of all curtain walls. Here is a photograph of the West Columbia Elementary School, West Columbia, Texas, which consists of large slabs of marble ⅞" in thickness under and above windows. As you can see, the erection was simple.

The marble was installed in sash and then the retaining frame screwed into place (Figure 5).

This wall had no back-up, no insulation,— it is the wall. This is in a southern climate, to be sure, but how simple it would be to attach insulation and interior finish to a similar installation where climate makes it necessary.

Figure 6 shows the detail followed in the International Business Machines Building in Kingston, New York. This is Plate F in the M.I.A. Specifications booklet.

Figure 7 shows how the marble, the exterior marble, by the way, was applied or set in place from inside the Gulf Oil Corporation Building in Atlanta, Georgia.

Figure 8 shows how the rigid insulation was applied directly to the back of the slab. The interior plaster wall, by the way, was applied directly to this insulation. Incidentally, the building was built in 1950, almost six years ago, and my reason for showing it was simply to point out that the research carried on by the industry in the past was not without its results.

As you can see from the vertical section shown in Figure 9, the ⅞" exterior marble

FIGURE 8. Rigid insulation is applied directly to the back of the marble slab on the Gulf Oil Corporation Building, Atlanta, Ga.

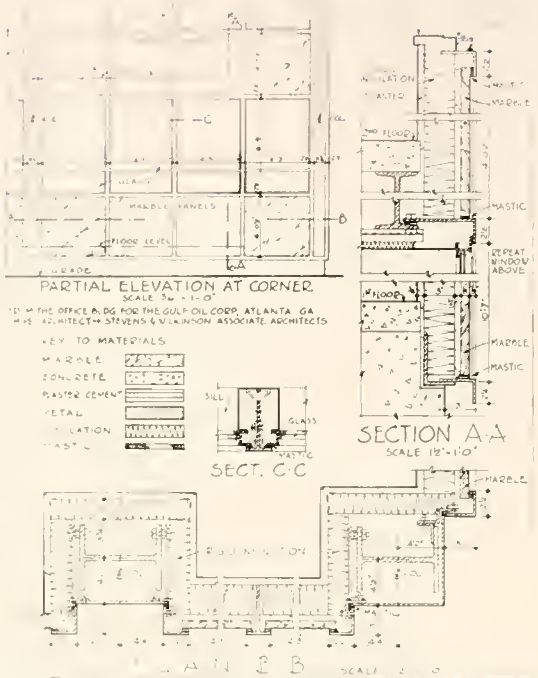


FIGURE 9. Detail Plate No. D from M.I.A. Standard Specifications showing section through Gulf Oil Building wall.

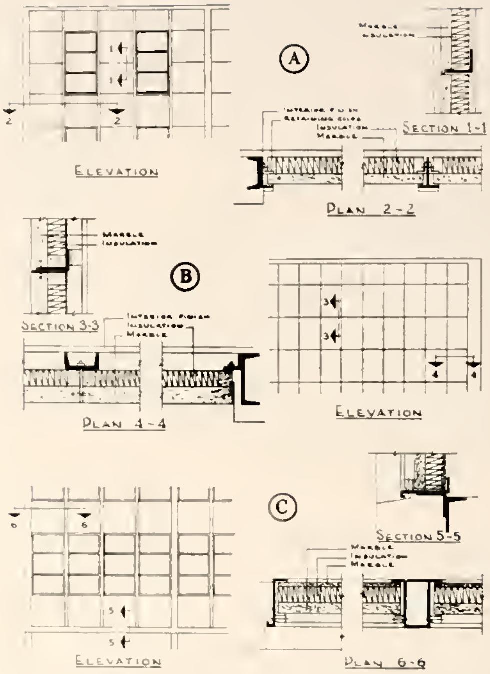


FIGURE 10. Marble Curtain Wall Panel Units. "A" shows marble plus insulation. "B" shows marble plus insulation in marble frame on back. "C" shows marble plus insulation plus interior marble.

FIGURE 11. Marble panel with insulation and interior finish all enclosed in metal frame and ready for immediate installation at the job site.

FIGURE 12. A detail of the corner of the panel showing how the panels interlock during erection of the marble curtain wall.

panel is backed up with ½″ parging and air space which, with the 3″ rigid insulation, finished on the interior with ¾″ of plaster, makes the total wall thickness just 5⅛″.

If the thin curtain wall or panel wall type construction had come along before we knew how to cut marble into thin slabs, I really don't know what we'd have done. Fortunately, however, long before I became identified with the industry—and that goes back nearly half a century—equipment was available which was capable of cutting marble into 2″, 1″, and even ½″ slabs. Most of this marble in the thinner dimensions, as you well know, was confined to use in building interiors. Even with the equipment generally available today, special care must be used in cutting marble to the smallest thicknesses. But machines, which are now beyond the development stage, will be able to economically cut marble as thin as its structural strength will allow, and it is here that the architect, the designer and the building owner can take advantage of the unique virtues of marble. For whether the marble in a building is ⅞″, 7″, or 7 feet thick, it still has the same beauty; it still has the same luxurious appearance; it still retains its color, its pattern and its features of low maintenance and easy installation—all the features which you know, and which I promised not to mention, but I do.

The current trend is towards further reduction in weight, not only in the marble itself, but in an entire, packaged, through-the-wall unit. Also, there are many advantages to having the exterior facing, the insulation, and even the interior finish supplied to the job site in one package. Perhaps the principal advantages would be those of simplifying the erection and reducing the cost of the installation.

Working along these lines, the industry has progressed far in creating these units, some of which are indicated in Figure 10:

A—Marble plus insulation
B—Marble plus insulation in marble frame
C—Marble plus insulation plus interior marble

Here we have three typical ways in which marble can be designed into curtain wall panels.

"A" shows marble with insulation attached to it. This is very much like the panel used in the Gulf Oil Building (Figures 8, 9, 10), but remember that this panel would be delivered to the job site as a unit with only setting into the frame to be completed in the field.

The center sketch, "B" shows another method we've been exploring. The back of the marble is framed with 2″ wide marble strips which are securely attached to the slab. The insulation is fastened against the back of the slab in the recess formed by the frame. The frame of marble gives better bearing and it also provides deeper marble-to-marble jointing, which is desirable. In addition, it gives the necessary support to the insulation in handling and erecting.

Plan "C" shows the complete curtain wall package unit with exterior finish, insulation, and interior finish, delivered to the job complete and ready to install.

One of the most interesting phases of research consists of the work done to formulate marble panels in sturdy metal frames. Interlocking, insulated members which can be snapped into spandrel framing in the building have been developed.

Figure 11 is a general view of the panel. Figure 12 is a detail photograph showing the frame close up. You can see here how the members interlock; note the groove and slot provision for snap-in installation.

Specifications on this panel are:

Marble—Ozark Famosa
Finish—Hone Finish (Waterproofed)
Insulation—Styrofoam #33 (Expanded Polystyrene)
Back—Flextos Board
Adhesive—Permanent Fire Retardent Surface Coating

Calking Compound—Thiokol Base

Frame—Aluminum frame designed to be used with curtain wall system

Weight—104 pounds (including frame)

Dimensions—4′ 7-5/16″ x 2′ 6⅞″ to outside of frame

Panel thickness—1¾″

This panel, including the frame, insulation, and backing, weighs less than 9 pounds per square foot.

These are not the only innovations being researched by the marble industry. Although I will not have time to go into them in detail, I want to list a few other areas into which our research program is leading us:

New finishes for marble for exterior use that would enhance the natural color and markings of the marble.

New and improved methods of anchoring marble to the structure of the building.

New and improved methods of packaging marble for shipment.

I have confined my remarks here to exterior marble used as masonry, but there are many applications on the interior where these ideas have great potentiality.

These projections of research are presented with the full realization that much engineering and architectural design will be needed to adapt them for specific installations.

The marble industry looks forward to new suggestions and ideas, to further experimentation, where advisable, by, for and with the architect, contractor and owner.

Veneer or curtain wall, or a combination of both, in marble can and will be provided if specified.

The supply of marble is unlimited, and experts tell us that it will not be exhausted for thousands of years. The marble industry is well prepared to provide marble for the heavier walls, for monumental buildings, as well as to provide it in thinner slabs.

Marble, one of the oldest of building materials, is modern through the ages and will continue to be modern because of its adaptability to changes in architectural design.

Brick and Tile Research

Robert B. Taylor
Structural Clay Products Research Foundation, Geneva, Ill.

MR. FISHER: *Our next speaker is the Director of a great new laboratory that is now serving the masonry field—the Structural Clay Products Research Foundation Laboratory at Geneva, Illinois. This little laboratory, I'd like to mention, has space inside for the erecting of large full-size structures, one and a half to two stories in height. I think we can look for tremendous results out of this laboratory in the coming years and for exciting things right now.*

Mr. Taylor was educated at Denison University and at Ohio State. He is a member of the American Ceramic Society, a member of the Building Research Advisory Board, and a representative to the Building Research Institute from his Research Foundation.

THE Structural Clay Products Research Foundation was organized in 1950 by clay brick and tile manufacturers in the United States and Canada to undertake research aimed at improving the competitive position of brick and tile in both present and future markets. Its membership has subsequently increased until today there are 110 U. S. and 28 Canadian manufacturers participating. This research effort began as an exploratory five-year program with its future beyond that date to be reviewed at that time. A total of one and one-quarter million dollars was subscribed by the membership for this exploratory period. At the end of three years, however, the membership had seen sufficient results, and could see sufficient future progress, that it decided to establish the Foundation on a permanent basis. The

income of the Foundation today is approximately $500,000 annually, and it has current assets of nearly one and one-quarter million dollars. This reserve is intended to smooth out any ups and downs in the sales curve of the industry and will permit the Foundation to undertake important long range programs rather than planning expediently on the basis of each year's income only. The current operating budget is approximately $500,000.

Since its very beginning, the Foundation's principal research objective has been what we call "end-use" research, dedicated to seeking means for putting our industry's products "in-the-wall" at a lower total over-all cost. Three approaches have been taken to implement this objective.

No. 1, we have critically examined many current wall designs to determine if a simplification of wall design will utilize the strength of our materials more efficiently, or improve the performance of the wall.

No. 2, we have also looked into the design of specific clay units for specific markets to determine if changes in unit design could be made to simplify wall construction and reduce over-all wall costs.

No. 3, we have critically examined site construction techniques to determine those conditions at the job which should be eliminated or modified to improve both mason and laborer productivity.

In connection with approach No. 1 above, the "SCR insulated cavity wall"* was developed. This wall, incorporating a special low density porous insulation especially developed for it, gives a U factor of 0.12 with exposed masonry on the interior and exterior surfaces and at the same time performs as a true cavity wall in preventing transfer of moisture from the exterior to the interior. Other walls are also being studied to determine possible modifications. This is particularly true of masonry walls normally thought of as non-load bearing elements. Tests to date indicate that many such partitions of relatively thin thickness have very real structural strength and might well be considered as economic load bearing elements in a structure. For example, a 6″ facing tile partition built of 4″ units and 2″ units has been found to be a very efficient load bearing element.

The first result of approach No. 2, improved unit design, was the development of "SCR brick,"** first announced to the construction industry in May of 1952. This unit was developed for the large percentage of current home building that is one story in height. It builds a single wythe wall, nominally six inches thick, that does not require either masonry or frame structural back-up materials. Because only 4½ units must be laid per square foot by the mason, it radically reduces the number of units he must lay per square foot and increases his wall area production per day by nearly 100%. To date more than 30,000 "SCR brick" homes have been built and the sales curve is still rising sharply. It has definitely been established in many, many areas of the country that "SCR brick" homes can be built and sold directly competitive with quality wood frame construction.

In addition to its original application for one-story homes, physical tests of the "SCR brick" panels have indicated that its properties make it suitable for many other applications. Schools have been built with it. In several areas of the country it has been used for very satisfactory, economical curtain wall construction in multi-story buildings. Motels, one-story factories and load bearing industrial partitions have become a developing market for it. Its properties are sufficiently unique that we believe that it can also serve as the load bearing frame structure for certain types of cellular multi-story buildings, ten to fifteen stories in

* Reg. T. M., SCPRF.
** Reg. U. S. Pat. Off., Pat. Pend., SCPRF.

height, as described in the Architectural Record in 1952 by Davison and Monk.

In regard to approach No. 3, improved site techniques, we have looked critically at the site problems of both the mason and the laborer. In regard to the mason we have found that continuously adjustable scaffolds, which keep the mason in an optimum working position with respect to the wall he is building, can markedly improve his productivity without increasing fatigue. In these scaffolds provision is also made for keeping the mason's supply of brick and mortar at a convenient height and location behind him. These improvements in scaffolding techniques by actual test have demonstrated that they can improve his productivity between 20 and 25%.

As a result of the Foundation's work in this scaffold field three new scaffolds of this type are now on the market. The "swing" scaffold for multi-story construction work is also ideally suited for this purpose, provided it is sufficiently wide to install a material platform of proper height behind the mason's working position. We have found that a marked nylon line which is now available for both modular and non-modular units can reduce costs in the original dry bonding of a wall and can also aid the mason in keeping bond throughout the construction of the wall. The strength of this line in comparison to its weight permits longer lines to be run with fewer intermediate supports and thus can speed up the work and improve workmanship.

More than 200 buildings of all types, sizes and end-uses have been built by contractors employing this complete "masonry process." We know that it does work, that masons are receptive to it and in many areas are using it effectively at this moment. Their productivity increases are resulting in a marked reduction in masonry construction costs.

In the field of laborer economics we have developed a new type of brick and tile package for the handling of our products by mechanical means from the plant all the way to the scaffold position of the mason at the wall. In its brick form, the package contains 62 brick made up of three strapped bundles of 20, plus 2 spacer brick. This package is adaptable for both large and small types of construction, by both large and small contractors, and can be handled by hand trucks on small jobs, or in multiples on large jobs with mechanical fork lifting equipment. One contractor on a small house saved more than $18.00 per thousand brick through the use of this package. This package is not currently economical for our members to produce by hand strapping and assembly methods. Therefore, a year ago we began the development of an automatic packaging machine which will produce these packages at an economical cost at the rate of 100,000 brick per day with a minimum of plant labor. This machine has been completed and is now being made ready for a plant trial installation.

In summary of our attempts to lower wall costs, we believe we have made real progress already and that some of it is being effectively used in the field today. We are also very hopeful that much more of this current work will have a real impact on the construction industry shortly.

While new products were originally subordinated to our "end-use research," they are becoming an increasingly important factor in our development work. While "SCR brick" is primarily a new unit design it is also a new product in terms of manufacturing and production problems. We now have 72 manufacturing licensees, and it has established a very desirable economic place in our industry's sun.

Another new product, designed for a specific market, has been named "SCR re-nu-veener"*. This is a ¾ inch thick clay slab with a "Norman brick" face size. It has a special shape geometry that permits rapid attachment of it

* Reg. T. M., Pat. Pend., SCPRF.

to existing wood or fiber sheathing with special metal clips to hold it in place. The joints are filled with a real mortar applied through a special pressure gun which we have developed. Special L-shaped corner units are employed so that a genuine brick appearance is achieved. Economic studies indicate that it can be applied in place and be directly competitive with many types of residing materials on the market. It also has a very definite place for interior redecoration of existing buildings since it will not require the strengthening of walls or floors to carry its weight. It is currently being test marketed in the Columbus, Ohio, area to learn marketing techniques and facts prior to its national introduction to the building industry. If this new product reaches 10% of its potential market it will provide a 58 million dollar annual market for our Industry in a remodeling field in which it has never had a major foothold.

At the present time in another of our major markets it has been established, and I am sure it will be confirmed tomorrow, that masonry curtain walls are one of the most economic forms of construction available on the market today despite all claims to the contrary by the panel wall people. Even in the matter of speed of building enclosure, the proper size mason crew for a job can still keep up with the other trades that must complete their work in the over-all construction schedule. The one dubious advantage that panel walls today might have lies in their reduced thickness. In order to protect our future economic position in this field we have been carrying on considerable long-range work in precast panelized wall sections for exterior curtain wall applications. We have developed an extremely fast setting cement grout which will enable us to produce such panels without large mold investments. In its exterior applications, such panels are two and one-half inches thick, and reinforced to carry the required wind and other structural loads. Only two sizes would be needed in any specific building. It appears that these panels can be produced at a plant price of $1.00 per square foot and installed with lath and plaster interior for another $1.00 per square foot.

We have also produced a structural ceramic glazed clay tile unit four inches thick that has a sound absorption of 60%, and a sound transmission loss of 47 db. unplastered and 54 db. plastered on the back side. Production equipment for this tile is currently being developed.

A process for the production of economic lightweight clay units has also been developed, and is currently being refined on a pilot plant scale. It will permit a reduction of weight for structural brick and tile units of 40% in addition to that weight saved through coring. In other words, a current five pound brick would weigh three pounds and the eight pound "SCR brick" would weigh less than five pounds. This lightweight process provides sealed cells, and the water absorption of such units is not appreciably higher than current clay bodies. Our process, which we believe to be unique, will permit the production of such units by nearly every one of our member manufacturers despite the great variation in clay properties that exists in our industry. It will permit a greater control of unit size, and will make grinding to exact size an economic possibility. Best of all, it can be produced with the existing facilities of our industry without requiring that they be obsoleted or discarded before this development can be offered to the construction industry.

Another important current phase of activity of the Foundation involves physical research to learn new facts about the behavior of clay masonry walls from a thermal transmission basis. I believe we have the most elaborate building thermal research program under way in the country. We have built six test buildings with six different types of masonry wall construction, and one identical building with metal panel walls and another identical build-

ing with wood frame walls. Each building is heated and cooled as desired by a special air conditioner and electrical heating device. Hundreds of thermocouples and dozens of heat flow meters are employed plus a very elaborate control and instrumentation building. These tests are already showing that the thermal capacity of masonry walls can be a decided factor in reducing the initial size and cost of heating and cooling plants. They are definitely showing that the U-factor of a wall is not necessarily the only factor that will determine the thermal performance in a building of a given wall construction. The first public progress report on the results of this research has been given to this conference earlier today by Mr. C. B. Monk.

Fundamental research into mortars has begun to show real progress. Certain cement combinations currently under study are developing ultimate bond strengths in excess of 200 psi, instead of the more usual 50 psi. It is still a mortar that can be handled with the trowel. Fundamental research into efflorescence and greenstaining is developing knowledge that is already being employed in some of our plants to reduce this problem in wall appearance. Improved methods of cleaning mortar stains from masonry have also been developed.

In connection with efflorescence, I would like to call the following facts to your attention. Sometimes on a given building, architects, contractors and owners find efflorescence on clay units which in the past have never given them any trouble. It must be remembered that efflorescence means that there was water within the wall to carry soluble salts to the surface. Without such water, regardless of where it originates, efflorescence cannot occur. We have also established that even if the brick is absolutely efflorescence free, serious amounts of efflorescence can result if there are soluble salts in either the mortar or the back-up masonry materials. It has also been established that even if the bricklaying workmanship is perfect so that water cannot enter the exterior face of the wall, efflorescence can still occur if proper flashings have not been installed at critical points in the building or if moisture vapor is not prevented by suitable vapor barriers from entering the wall from the interior side.

A large amount of our work in the past and present involves architectural research studies. For example, facing tile shapes are being analyzed with a view to a simplification of shapes to reduce plant production and inventory problems as well as the design of such walls by the architect. It is believed that this study will permit more rapid deliveries of facing tile to the public and will make estimating of facing tile a much simpler procedure.

Architecturally and structurally we have also studied school construction requirements and costs. There has been a substantial amount of publicity given to purported savings in school construction costs by means of prefabrication of buildings constructed of either metal or wood. Widespread claims have been made that such schools can be erected for the school board at classroom costs of 15 to 20 thousand dollars. This has been coupled with the claim that this cost is one-third or less of the usual typical masonry school which has been stated to be as high as 50 thousand dollars a classroom. Our school cost studies have shown the "per classroom cost figure" to be completely misleading. On a recent public platform with me one of the prefabricated school suppliers stated that they had just completed a six classroom school for \$120,000, or \$30,000 per classroom. The square foot cost of his building, however, turned out to be more than \$18 per square foot of space. There are many, many masonry schools being built today in all parts of the country for costs of 10 to 12 dollars per square foot. Further, they provide the school board with yearly savings in the form of low

maintenance and operating costs, real fire protection for the students and the wealth of color and architectural form that architects can so well fit to the local site and surroundings.

In a desire to provide a simplified design for even lower cost masonry schools we have also developed a concept of load bearing interior wall construction that, in the Chicago area, can permit economical masonry school construction at an estimated \$8.35 per square foot including the mechanical services. A similar cost study in Texas employing this concept yielded an estimated cost of \$7.14 per square foot. However, contracts for three schools of this type have since been let in Texas at square foot costs of \$6.71, \$6.86 and \$7.25, respectively. This is dramatic proof that real utilization of the structural properties of masonry combined with the attendant savings in the roof and framing structure can result in a balanced design of maximum economy.

A recent phase of our work that has been extremely interesting is a series of high explosive shock loading tests of various masonry walls. In the final test, 8 walls were simultaneously tested in an octagon test-fixture approximately 30 feet in diameter. Four of the walls were mounted as vertical beams, 9 x 10 feet in size. These were: (a) standard 8″ brick and block construction; (b) 8″ reinforced lightweight concrete block; (c) 9″ reinforced grouted brick wall with the same amount of steel as in "b"; (d) 9″ reinforced grouted brick wall with twice the steel of "b" and "c". The other four walls were tested as horizontal beams with end restraint against pilaster-type piers to develop "arching" action. These walls were 10 x 9 feet in size. They were: (e) 8″ brick wall (unreinforced); (f) 12″ brick wall (unreinforced); (g) 9″ reinforced grouted brick wall with the same steel as "b" and "c"; (h) 6″ "SCR brick" wall with 2 pencil rods in every other horizontal mortar joint.

Forty-five pounds of high explosive were detonated within the octagon, developing a peak surface pressure of 140 psi for 3 milliseconds. This is in excess of the energy impulse sustained at 4700 feet from ground zero during Operation Cue's atomic building test in 1955. At that time, wall "a" in a two-story home failed, and wall "b" in a one-story structure withstood the blast. In our test, these two walls were employed as control specimens to provide direct comparison with Operation Cue performance.

In our test, wall "a" was completely demolished as at Operation Cue and wall "b", which survived Operation Cue, was completely destroyed. *All six of the other walls stayed intact and were all structurally sound after the tests.* This dramatically illustrates the fact that economical brick walls can be designed to withstand the tremendous lateral pressures generated in atomic blasts, earthquakes, hurricanes and tornadoes. The engineering design criteria developed in this program are being assembled into a "hand-book for blast resistant design" to be released to the architectural and engineering profession this fall.

We began our research effort in 1950 by employing the technical and industrial research facilities and staff of Armour Research Foundation of Illinois Institute of Technology. This was supplemented by contractual arrangements for our architectural research with the architectural firm of Howard T. Fisher & Associates of Chicago. In 1951 we leased laboratory space of our own to supplement the contract work, and began to acquire our own staff and equipment as our objectives and programs began to develop and mature.

In 1954, our management demonstrated its faith in its research effort by authorizing the establishment and construction of a new national Research Center for our industry. It was built on a 15-acre site 40 miles west of

Chicago in Geneva, Illinois, and occupied last fall. Within the engineering section of this building full size two-story homes, or two-story prototypes of a multi-story building, can be erected to study engineering and construction techniques and to develop short cuts that will result in lower construction costs. Space has also been provided for the establishment of pilot plant production lines such as for the automatic packaging machine and for the pilot production of pre-cast wall sections. Facilities have been provided for engineering study and testing of full size wall sections for water permeability and for compressive, transverse and racking strength. Complete ceramic research facilities of both a fundamental and production nature have been installed. Engineering and architectural laboratories have been provided. Sufficient land is available at the site to permit the outdoor erection of full size prototype structures to test building techniques and materials developed in the laboratory.

For specialized personnel or equipment, or for certain projects of short duration, we still intend to employ the services of established research organizations.

The Foundation with its adequate reserves, new facilities and trained staff, is dedicated to the improvement of masonry structures and to the development of more economical ways in which to build them.

Research has given our industry a new look into its future—a new confidence in that future—a future of better present products, and with new products for new markets. It has encouraged the Industry to increase its capacity by more than 20% in 1955 and 1956. Truly, research is enlarging the frontiers for brick and tile and we are confident that our industry will continue to maintain its pre-eminent position in the construction industry, both today and tomorrow.

Discussion

MR. FISHER: Our first question is directed to Mr. Howe: With expansion and contraction in New England temperature ranges, what is the maximum size sheet recommended for marble veneer if maintenance of joints is desired?

MR. HOWE: I think we said this morning that the maximum size is what the quarry would produce, but it would vary some on the quarry itself as to size. But I'd think the maximum panels would be somewhere in the neighborhood of six to seven feet long and three to four feet high. Although the other day we had one 15-foot square.

MR. FISHER: Mr. Taylor, what provision was made in your blast tests to compensate for the pressure relief afforded by the failure of walls in determining the resistance to the blast?

MR. TAYLOR: The velocity of the mass propagation and the short duration of the total blast of only three milliseconds. Our pressure measurements indicated that there was no diminution of any specific wall, because two walls went out.

MR. FISHER: Here is another question to Mr. Howe: Is any serious work being done toward structural applications of natural stones, such as prestressed stone assemblages, utilizing new cutting methods and high strength, low creep characteristics of stone?

MR. HOWE: I don't believe so.

MR. FISHER: In these panels Mr. Taylor just spoke of, they are using the brick structurally there. I think they first asked that question, wondering if any similar work was being done in the marble field.

MR. HOWE: I'm not on the research committee of our institute, but I have not heard that they are starting that as yet.

MR. FISHER: Here is a question for Mr. Monk. If you had used a porcelain enameled panel instead of a galvanized one, would your results have been any different?

MR. MONK: The only difference would have been in the color. And you will note that

I emphasized, but I didn't have a chance to explain it, that the frame hut was white. The metal hut happened to change to a dark color, so we had two extremes of color so far as mass was concerned. The enamel, of course, would be somewhere between these two extremes. The difference probably would be only in color, and therefore it would be someplace between 15 per cent and 50 per cent heat loss in excess of what you can expect with normal U factors.

MR. FISHER: Here is a general question to all of the technical speakers this afternoon. If the jointing material for masonry is more important than the masonry material itself, why then has this important factor of masonry work not received more discussion by technical speakers of this conference?

Before passing that question on, I would like to say it is my own impression that a considerable portion has dealt with the relationship to the jointing between panels.

Who would care to comment? Mr. Taylor?

MR. TAYLOR: From my point of view, I'd say it takes approximately 25 per cent of our total research, both in the prefabricated panels and research having to do with standard type units. And we have work, as I mentioned, where we have achieved 200 psi bond strength compared to 50 psi. We also have evaluated mortars. It's a very important thing, because the strength of a clay wall is no better than that of its weakest component, which in this case happens to be mortar. And it is essential, to get the best results, that the design of our industry's products follow the kinds of specification we know will really give good performance.

MR. FISHER: Would anybody else like to comment on that last question? Mr. McKnight?

MR. MCKNIGHT: I think, Mr. Fisher, along with joining mortar there has been quite a revolution in the mastic industry in the last year with some new discoveries in mastics, which we have used in broadening our scope in joining these panels.

MR. FISHER: How permanent are the penetrating stains to outdoor exposure? Mr. McKnight.

MR. MCKNIGHT: We have run some of the most elaborate barometer tests possible with the latest equipment. We know definitely that we can penetrate with special spraying equipment the stain to a depth of a quarter of an inch. That is considred an average because we do have some variance of natural material. From all indications from the technicians and engineers, we can say, for all reasonable applications, it is good for 15 years.

MR. FISHER: Mr. Barnes, can satisfactory lateral deflection of one story with respect to the next be permitted, say ½-inch per story, with safety to the panels? I assume the questioner has in mind the wind stresses on the building possibly cracking the terra cotta.

MR. BARNES: We were faced with that on a recent project in Oakland, where it was expressed in ⅜ of an inch drift per story. That depends entirely on the connection and it is quite practical, and the material itself is very adaptable to the proper connection for that.

MR. FISHER: What is the effect of stack bond versus running bond in RBM? Mr. Dickey isn't on our panel at the moment. Would he care to comment on that from the floor? Someone said this morning they thought it would not have too much effect on the strength.

MR. DICKEY: Yes. Normally the engineers just don't like to look at the stack bond. It doesn't look as strong, but the tests show

that we shouldn't look down at stack bond, that we should be more optimistic. Tests showed that reinforced stack bond would be just as good as your design valuation but that your unreinforced running bond would be eight times as good, which would indicate an extremely high factor of safety in masonry.

MR. FISHER: What is the relative cost of cut stone and clay brick—say a cost per cubic foot? What is the minimum thickness of stone paneling? Mr. McKnight?

MR. MCKNIGHT: Well, Mr. Fisher, there are several things that are contingent here. For one thing, freight rates, location of the job. But for the most part, you have the source of brick near every metropolitan area in the country. Whereas limestone is very limited as to its location in areas.

With regard to that last question on thickness of our panels, today we are working on two inches. They have been adapted and are being applied now to the two-inch thickness. We had it down to one inch, but at the present time our specifications call for the two-inch thickness.

MR. FISHER: Mr. Taylor and Mr. Monk, has any research been done on the prospect of reducing the thickness of joints on S.G.F.T.—I'm not sure just what this means—without grinding on the job, especially double-faced partitions?

Can you comment on the general problem, Mr. Taylor, of joint thickness and how you look upon it in the future research?

MR. TAYLOR: It is a very important problem, and the control of clay to an exact size is often difficult in some of our clay products. But in terms of some double-faced partitions, they are available in some places in this country in two colors. The surfaces are glazed. Such units are available in certain types of manufactured units today. We do feel that when we have a lightweight aggregate that we will come even closer to having that same control size available in all of our clay products.

MR. FISHER: How deep does the color stain penetrate limestone, and can it be applied on the job? Mr. McKnight?

MR. MCKNIGHT: I think, Mr. Fisher, that I answered that question a minute ago when I said as an average the stain can now penetrate to a point of 3/16 of an inch to a quarter of an inch, according to the density of a product. You have to understand that, with the process of this special spraying equipment, you can put the stain into the stone with an absorption point where it will last for 15 or 20 years. But you also have to take into consideration that stone is a natural product and will vary maybe sometimes within four or five feet running length. But I am speaking now of the average, and we will say it is 3/16 of an inch as the average and is good without any noticeable fading for 15 years.

MR. FISHER: What are the limitations in the use of highly-colored and figured marbles for very thin slabs? Mr. Howe?

MR. HOWE: Well, of course up to this time we have used generally what we call the sound marble. But studies are going on, and I am sure in the days to come we will find ways to perfect nature's shortcomings to use the colored marble very successfully.

MR. FISHER: This is in connection with granite and marble research. How are the marble panels attached to the building frame to prevent moisture penetration, to permit structural deflection, but to be safe in earthquakes? Mr. Howe?

MR. HOWE: I don't believe that I will attempt to answer that, sir. Of course on the west coast the present requirement is that the marble panel, as an ordinary veneer, is joined

to the structural wall. I'm not experienced with this earthquake question.

Mr. Fisher: Mr. Barnes, what type of material is used for the intermediate or false joints in your panel? How was a satisfactory bond effected?

Mr. Barnes: The jointing mortar, I presume, is what is referred to, between the various elements of ceramic veneer in the one panel; and that is a rather dense jointing mortar application, approximately one to three, with one quarter part lime and a small amount of ammonium stearate added.

What was the other part of that question?

Mr. Fisher: Well, it's just the same question, how is the satisfactory bond effected? I assume the material achieves that.

Mr. Barnes: Yes, it will. If the bond material is well dampened, there is no problem on the bond.

Mr. Fisher: Mr. McKnight, are these penetrating stains inorganic colors?

Mr. McKnight: Yes, they are. These stains have been developed not through our own laboratory and engineering abilities or facilities, but we have gone to some of the major chemical companies throughout the United States, told them what we were after, told them what the potential was, and they in turn worked with us in this coordinated effort in developing the stain.

As a matter of fact, today has been the first time a member of the Institute has released them; and the specifications prepared for them will be distributed to the construction industry in the near future.

Mr. Fisher: Mr. Taylor, your institute has in the past frowned on silicones as a surface water-repellent treatment for brick, etc., presumably because of suppression of efflorescence and hence promotion of spalling. Is the Institute still committed to that position?

Mr. Taylor: I have had experience with silicones and a knowledge of them for a very long time. In fact one of my best personal friends, probably, is the inventor and original developer of silicones; and I am the first to admit that they will stop penetration of water through certain size pores and with a breathing action remaining. But they will not span, necessarily, cracks of more than a certain size, nor will they close up joint mortar cracked by erosion or other types of defects, unless the wall is first tuckpointed. I spoke about some of the danger of efflorescence due to interior water entering the wall from other sources. We have firm proof and we have a building to point to in which silicone was put on it to cure the leaking condition that existed, without first putting the building into good masonry repair. And more than half the brick in that building have spalled. There are slabs a half-inch thick around the base of the building. And silicone applied properly will do a good job with masonry where special conditions make it necessary to use it. But I would hate to be the guy that put silicones on a building, made the decision to do it, and have to pick up the tab for rebuilding the building. And that is why we take that position. At one time our industry even considered supplying and furnishing contractors with silicone that we'd mix in our own plants. But we had to abandon that. It happens that, when soluble salts in the brick or mortar are dissolved, that solution of salt moves to the surface like normal water, only it is carrying efflorescence salts. When it reaches the silicone, it can move no further, so evaporation of the liquid takes place at this point, because the surface is porous and crystal pressure develops which

can be as much as 4,000 or 5,000 psi locally or cause splitting of the brick itself.

MR. FISHER: Mr. McKnight, do your through-wall panel tests indicate that the use of Tectum insulation board, as the back-up for your exterior stone panels, affords sufficient water resistance to repel driving water surface penetration from rain storms?

MR. McKNIGHT: We have run tests on this natural stone facing utilizing a number of well-known insulating materials. The use of Tectum for a complete through-wall panel is, however, still in the testing stage. We have not as yet officially released such a wall for recommended use, but anticipate doing so in the very near future.

My picture of a through-wall stone faced composite was not Tectum but foam glass manufactured by Pittsburgh Corning Corporation.

The many tests we have run for thin natural stone wall panels in combination with insulation media have successfully passed our laboratory requirements. The U factor has been highly satisfactory. It should be noted that the insulation part of the unit assumes no structural function. It is, rather, a medium to which natural stone facing or possibly a natural aggregate composite can be bonded.

The other type of panel which we have released will probably mostly be used in the commercial field. On this panel we apply several thin stone pieces to a single sheet of Tectum. In this manner we can construct a thin, stone-faced panel of almost any reasonable size. We are making use of this development on a large shopping center at Indianapolis. The panels we use there are 10′ high and 30″ wide and consist of 2″ of limestone mechanically fastened to 2″ of Tectum. The masons working with this new material for the first time anywhere achieve a setting rate of approximately 1,200 square feet per day. This is not a complete through-wall. But the combination of natural stone and insulation reduces the wall weight in addition to providing a high insulation value, low cost, and speedy erection. The panels are anchored into the back-up of structural steel with strap anchors and dowels. This type of construction is highly practical and may be adapted to many designs.

MR. SILLING: I think one of the most interesting things about these sessions that I have always found tremendously impressive, and that has impressed people from other countries who visit technical sessions in America, is to find the wheels within wheels. And while they may respectively rub abrasively against each other, I invite you to remember that they also do interlock; and I think that is a very interesting commentary on industry and private enterprise in America.

PART FOUR

Costs and Maintenance

PRESIDING CHAIRMAN:

W. E. Reynolds

Consulting Engineer, Washington, D. C.

MR. SILLING: In the past, whenever I met your next session chairman, he did the presiding and I was listening, and very carefully. You see, he was in a position to make me rich. He was the Federal Commissioner of Public Buildings and hired architects by the hundred. They had to certify their record on a government form in a definite, prescribed manner. There was no place to show those beautiful red, white and blue pipe dreams that architects are very fond of drawing to mislead their clients, and he would not listen to any fancy talk. A hard man—but fair. And with a sharp knowledge of how to use an architect effectively, and also how much or how little to pay him.

Even under other personnel, the department that he headed up still persists in that manner.

He was educated as an engineer. However, architects have long since forgiven him for this oversight. We are proud to count him an honorary member of the American Institute of Architects and publicly declare our sincere affection for him. Gentlemen, Mr. W. E. Reynolds, Consulting Engineer of Washington, D. C.

In-The-Wall Costs

H. T. Noyes

Turner Construction Company, New York, N. Y.

Mr. Reynolds: *I think that this particular session is one of the more important ones that you have at this meeting. It is very often overlooked by many people in the construction industry that maintenance is a very vital factor in the design of a structure. We have proved in various ways that it is sometimes profitable to pay more in first construction in order to eliminate maintenance, which is a continuing problem throughout the life of a building.*

It is now my pleasure to introduce Mr. H. T. Noyes, Assistant Chief Engineer of Turner Construction Company since 1926. He was chief building engineer and later chief engineer of the joint venture titled "Contractor, Pacific Naval Air Bases" at Pearl Harbor from October 1939 through July 1945.

He attended the School of Technology of the City College of New York and has a Bachelor of Science degree and a Civil Engineering degree. He is a member of the American Society of Civil Engineers.

Many great advances have been made in buildings since the end of World War II. These advances in design have greatly increased the usefulness of buildings and certainly the comfort and efficiency of their occupants. But they have increased building costs out of all comparison with general living costs.

While the walls of buildings have increased in cost in step with other items, their proportion of the total building cost has generally gone downward. This is particularly true of masonry-walled buildings, as is well illustrated

by a comparison between a 20-story office building built in 1927 and a similar 25-story building built in 1949-50. The brick and stone walls, including the windows, glass, etc., amounted to 19.8% of the total cost of the 1927 building. The similar walls of the 1949-50 building amounted to only 8.29%. The reason for this, of course, is the very great increase in the cost of mechanical work in the average building due to the addition of air conditioning and to a very great increase in the complexity of the electrical system in the newer building. The cost ratio of the combined electrical and mechanical items in the buildings mentioned above increased from 27.52% in the case of the 1927 building to 44.54% in the 1949-50 building.

The opinions of the great mass of people who look at, visit, and occupy buildings are greatly influenced by outward appearances. Because of this, the walls have retained and should retain very great importance in the development of any building design. Architects in endeavoring to obtain new and modern appearances are designing walls using masonry in its various forms, combinations of masonry with metal and glass, and combinations of metal, glass and/or other materials without the use of masonry.

While this conference is primarily intended as a discussion of masonry, no such discussions have any meaning without a comparison of the cost of masonry walls with other types.

The preparation of comparisons of costs of walls is not easy, as any such comparison must recognize that the costs divide themselves into two basic categories:

1. *Direct Costs*—including the cost of:
   a. Masonry
   b. Metal Work
   c. Spandrels
   d. Windows
   e. Dampproofing and Insulation
   f. Scaffolding
   g. Air Conditioning Unit Enclosures
   h. Lath and Plaster
   i. Sun Control Installation, such as Venetian Blinds
   j. Other similar items
2. *Indirect Costs*
   a. Effect upon Structural Frame and Foundations
   b. Effect upon Heating and Air Conditioning Systems
   c. Effect upon Lighting System
   d. Effect upon Speed of Erection
   e. Effect upon Rentable Area
   f. Effect upon Window Washing Equipment
   g. Effect upon Sound Transmission
   h. Effect upon General Comfort of Occupants
   i. Effect upon Maintenance
   j. Influenced by Code Requirements
   k. Influenced by Fire Insurance Requirements
   l. Influenced by Owner's Special Requirements, such as blast resistance design, as frequently required by the Telephone Company.

Direct Costs

The "Direct Costs" are the "in place" costs of the various materials which go to make up the building wall. These are usually shown in detail on the architect's drawings and can be readily estimated by a general contractor with the help of his various subcontractors.

Exterior walls may be built in almost an infinite number of combinations as designers strive for improvements in appearance, utility and cost. Each designer approaches the problem differently, and as a result seldom are two buildings built from exactly the same combinations of materials and details.

For comparison of wall costs we have analyzed the costs of some buildings of which we have knowledge and have corrected them for Turner Construction Company's Cost Index of July 1956.

Before presenting these, I thought that it might be interesting to give you a percentage breakdown of the various major items in a building which we built in New York in 1949-50. Today's building average is about the same.

Excavation and Foundations	4.53%
Steel Frame and Fireproofing	16.92
Brick and Stone Masonry, Windows and Glazing	8.72
Roofing and Flashing	0.45
Waterproofing	0.36
Interior Partitions	8.29
Metal Lath and Plaster	2.32
Carpentry and Millwork	1.26
Miscellaneous and Ornamental Metal	2.85
Cement Finish Floors	1.48
Tile, Terrazzo and Marble	2.35
Floor Coverings	0.52
Painting and Decorating	0.69
Acoustical Treatment	2.45
Finished Hardware	0.27
Security Vaults	0.60
Heating, Ventilating and Air Conditioning	19.55
Plumbing	5.59
Wiring and Fixtures	10.28
Elevators and Conveyors	9.12
Job Supervision and General Expense	1.40
	100.00%

In preparing the following cost comparisons, we have, unless otherwise noted, considered only the following items:

a. Masonry
b. Metal Work
c. Spandrels
d. Windows
e. Dampproofing and Insulation
f. Scaffolding

We have not included such "Direct Cost" items as Air Conditioning Unit Enclosures, Interior Furring and Finishes, Sun Control and similar items. These are not a feature of the exterior wall as being considered here, as the similar designs of each could be used with any type of wall. Further, their costs would not seriously alter our present comparisons. Some comments will be made later regarding them.

The following is a condensed listing of a number of unit prices for various buildings with different walls. The chart below shows the make-up of each of these walls in more detail. It must be recognized that these are only approximate prices to be used very carefully. Minor changes in location or condition might result in appreciably different prices.

Unit Prices For Various Buildings

Type	*Location*	*Description*	*Price/sf.*
1. 32-story office	New York City	Face Brick and Aluminum Sash	$ 5.20
2. 3-4 story lab.	New York State	Roman Brick and Aluminum Sash	5.47
3. 5-story hospital	New York City	Brick Cavity Wall	4.60
4. 25-story office	New York City	Limestone—Alum. sash and spandrel	7.40
4a. 25-story office	New York City	Limestone includ. spandrel—Steel windows	6.15
5. 6-story Telephone	Near New York City	Blast Resistant limestone and conc.	8.90
6. 2-story lab.	New York State	Alum. Porcelain Enamel and glass	6.30
7. 41-story office	Pennsylvania	Limestone with stainless steel windows and Steel spandrels	12.30
8. 42-story office	New York City	Stainless Steel with reversible sash	7.20
9. 3-story office	New England	Alum. Stainless Steel Trim and ⅜-inch Solex Glass	11.75
10. 2-story office	Near Philadelphia	Porcelain Enamel Stainless Steel and Glass	11.60
11. 1-story manfg.	Virginia	Concrete tilt-up and corrugated asbestos	1.22

All of the above prices are per square foot costs.

In addition to the above we have estimated the cost of several other types of masonry faced walls:

1. Marble faced exterior walls using ⅞-inch marble facing and 8-inch common brick should cost between $7.00 and $8.50 per square foot provided a normal domestic marble is used.
2. Granite faced exterior walls using 1½-inch thick granite and 8-inch common brick backing should cost about $12.00 per square foot.
3. Mosaic faced exterior wall in the form of a precast 8-inch Waylite panel of maximum size—5 feet x 10 feet—faced with Casavan mosaic would cost from $5.00 to $6.00 per square foot installed. This panel has a 4-hour fire rating and load carrying capacity of about equal to a 12-inch masonry wall.

These prices are for the area of the masonry and do not include windows, glass, insulation, etc.

Indirect Costs

To discuss "Indirect Costs" in any detail would require far more time than is available here. However, we believe that a few general observations might be well worth while.

1. *Structural Frame and Foundations*

For years Engineers and Architects have considered the effect of the weight of walls on the design of the structural frame and the foundations. Little more need be said about this except that the influence of the weight of the wall is far more important in tall buildings than in low ones and that Pile or other expensive forms of foundations are more influenced by weight than are rock or high bearing value soil footings. This problem lends itself to relatively easy analysis.

2. *Heating and Air Conditioning*

The effect of the exterior wall of a building upon the size and design of the heating and air conditioning system is very important economically and must be considered by the Mechanical Engineer in designing the system. In studying this effect, we took two building walls —each 8 feet long by 12 feet 6 inches high. In one building we assumed a "Conventional" wall of masonry and 30% glass area. In the other we assumed a "Window" wall of metal and panel construction and 70% glass area.

Heat Loss Calculation

Heat Loss through "Window" Wall:				
Glass	70 sq. ft.	100 BTU/hr.	7000 BTU/hr.	
Insulated Wall	30 sq. ft.	6 BTU/hr.	180 BTU/hr.	
				7180 BTU/hr.
Heat Loss through "Conventional" Wall: (Masonry portion is 12-inch brick with 2-inch furring of metal lath and plaster)				
Glass	30 sq. ft.	100 BTU/hr.	3000 BTU/hr.	
Insulated Wall	70 sq. ft.	6 BTU/hr.	420 BTU/hr.	
				3420 BTU/hr.
Excess heat loss through "Window" Wall				3760 BTU/hr.

One ton of refrigeration equals 12,000 BTU/hr.

Then the added AC load due to "Window" Wall is:

$3760 \div 12{,}000 = 0.3$ tons per 100 sq. ft. of wall area

Our calculations apply to the eastern and western walls of a building. They apply to a lesser degree to the southern wall and still less to the northern wall.

The first cost of the heating and air conditioning system for a large building varies between $800 and $1,200 per ton of refrigeration. If we assume that variations in wall type would merely alter the size of the system to a degree and that the price per ton for the added refrigeration would be only 50% of the above prices, the increased cost of the heating and air conditioning system in the "window" walled building will run from $1.20 to $1.80 per square foot of wall more than the "conventional" walled building.

As noted, these figures apply fully only to the eastern and western walls. If these walls total 30,000 square feet, the increased cost of the heating and air conditioning system would be $36,000 to $54,000. In addition the operating costs go up proportionately.

For a "rule of thumb" we may say that an additional ton of refrigeration is required for each 130 square feet of 12-inch brick wall with metal lath and plaster furring which is changed to glass. This means that if the added refrigeration cost $500 per ton, this change costs about $4 per square foot of increased glass area. This applies only to the eastern and western walls.

All of the above figures will vary somewhat with details, climate, exposure, etc., but still they indicate how carefully this factor must be considered when deciding upon a wall design.

3. *Lighting*

The lighting system of a building must be designed for the worst condition, which of course is night time operation. An increased window area does not alter the system. Our observation indicates that in most offices and factories the lights are turned on fully in the morning and turned off by the cleaning force after they complete the evening cleanup. Thus, in practice, no operating savings are obtained.

4. *Speed of Erection*

It would appear that any kind of panel system would result in greater speed of erection than is possible with the conventional type of masonry construction. We all are familiar with the spectacular speed of the erection of the outside skin of several aluminum buildings in New York City and elsewhere. However, it should be kept in mind that the speedy installation of the exterior skin is only one phase of the construction of the wall. In New York where masonry backing is required, it is found that the overall speed of erection of panel walls is not very much greater than the speed of erection of masonry walls. There might be some advantage during winter weather when a rapid enclosure for winter protection will save some money. It is difficult to assign a dollar value to this item.

5. *Rentable Area*

If the outside lines of a building are fixed by property lines or code requirements, such as is usually the case in a large city, the thickness of the exterior wall is of economic importance. The American Standards Association in conjunction with the National Association of Building Owners and Managers has established that the "Net Rentable Area" of a building space shall be measured to the inside finish of the permanent outer building walls, but no deduction shall be made for columns and projections necessary to the building.

In the case of a New York City building of an individual floor area of 26,000 square feet gross and 19,000 square feet rentable area and a story height of 12 feet, the wall surface per story was found to be approximately 10,000 square feet. A decrease in the thickness of

wall by 2 inches would have added 140 square feet of rentable floor area per floor. At a rental of $6.00 per square foot, the yearly income from this would have been roughly $840. This sum capitalized at 10% amounts to $8,400 or a savings of 84¢ per square foot of wall surface.

In considering this matter of wall thickness, it must be recognized that frequently too much effort is made to reduce wall thickness when it is not necessary or even desirable. An example is in a large building built where no property line or code requirements governed the size of the building. The wall thickness was designed down so much that more money was spent due to close tolerances than if an additional inch were added.

6. *Window Washing Equipment*

Whenever consideration is given to detailing the walls of a building with fixed glass, proper evaluation must be given to the method of cleaning the windows. In some large buildings built recently, machines have been built to ride rails on the roof and drop some form of car over the side for the use of the window cleaner. In some instances this equipment has cost over $100,000.

In a number of buildings built since the war, reversible sash have been used so that the window cleaner can stand in the building and wash both sides of the glass by reversing the sash. In one such building it was estimated that the cost of making these sash reversible rather than fixed was about $225,000. In this building window washing machines would have had to be placed on several levels due to set-backs, so that close analysis was necessary.

7. *Sound Transmission*

The transmission of sound through an exterior wall may be of great importance in some locations. Since sound is stopped principally by mass, the masonry wall due to its weight and mass has the advantage over any type of light sandwich wall or metal skin with light weight backing.

8. *Maintenance*

All types of walls need maintenance, some more than others. Those requiring cleaning, calking and painting or other regular attention should be analyzed to determine the emphasis to be given maintenance when comparing wall costs. This is a very complicated and controversial subject. We do not have any generally accepted information regarding the cost of such maintenance programs.

9. *Code Requirements*

City or state building codes frequently have requirements which greatly affect wall costs and must be given full consideration. Often they require a specific fire rating and sometimes give actual masonry thicknesses and material requirements. Wind pressure design also is important. No generalization of costs is possible here.

10. *Conclusion*

The foregoing is intended to indicate that many factors must be considered before selecting a wall type. Some of these are:

a. Aesthetics
b. Publicity
c. Use of the Building
d. Effect upon Structure, Foundations, and Mechanical Installation
e. Economics

Any of these considerations may be established by the owner as being of top importance. No one type of wall is best for all purposes or situations. One owner may select a wall which is the cheapest, another owner one which is outstanding in being different of modern, and still another owner must have one which fits into an existing pattern. Only a thorough study will give him the assurance that he has best gained his desires.

Maintenance of Industrial Buildings

Alf M. Myhre

E. I. duPont de Nemours and Company, Inc.

Wilmington, Del.

Mr. Reynolds: *Our next speaker is Mr. Myhre of the duPont Company. He is a specifications man. He is a designer with structural experience. And he is with a great company. He is self-educated and has been a construction superintendent and a designer. Mr. Alf M. Myhre is a registered professional engineer in Delaware.*

Until comparatively recent times, permanent industrial plant buildings were invariably constructed with masonry walls. Stone or brick buildings offered maximum fire resistance and endurance and lent themselves to minimum maintenance costs. Stone walls were inherently thick—two feet or more. Since labor was cheap, brick walls, too, had a thickness of twelve inches or more and provided, in addition to their function as an enclosure, support for floor systems. They were generally solid brick throughout their thickness. Under those conditions, masonry was pretty stable and very little cracking and leakage occurred.

The last twenty or twenty-five years have seen marked changes in industrial design. Increased cost of both labor and material has dictated many of these changes; others resulted from new technological requirements which necessitated more rigid operating conditions. The design of masonry walls has been affected along with many other building components. To accomplish lower costs, wall thickness has been decreased, while the masonry units themselves have increased in size. Greater use of cored units results from an attempt to adjust unit weight so that masons can handle larger sizes without increased fatigue—again an econ-

omy move. Walls have largely ceased to function as such; they have become enclosures . . . a skin to cover a structural skeleton.

During the period when all these changes were taking place, many attempts were made (and are still continuing) to come up with satisfactory substitutes for masonry walls. To date, however, masonry retains its position as the lowest cost, really fire-resistant enclosure for most kinds of industrial buildings. What other type of exterior wall can be constructed for a price as low as $1.50 per square foot and be as durable as masonry?

Yet, some industrial buildings which could appropriately use masonry walls are designed with some other type of enclosure. Why? There must be a gimmick somewhere in the above statements. Is the quoted cost too low? No: the above cost figure has been repeated time and time again on our jobs. Fire resistance? That characteristic has never been questioned. Durability? Masonry is the only form of wall construction that has endured through hundreds of years while retaining its original form. Aesthetic quality? Masonry in its various forms and multitudinous color variations should satisfy the most critical architectural designer. Maintenance requirements? Maybe: that's about the only factor left which could possibly be tagged with an unsatisfactory answer.

Masonry *is* occasionally subject to criticism. *Some* of that criticism is justified; *most is not.* Even though masonry walls occasionally crack and leak, we must remember that there are endless examples of installations which are functioning in a first-class manner and will continue to do so for decades. And, in spite of the selected accompanying illustrations, du Pont's experience, I know, parallels that of the industry in this respect. However, our particular subject is "maintenance" so we must, of necessity, point our discussion to the more vulnerable characteristics of masonry and find out what we can do to correct or eliminate them.

Why Masonry Walls Crack

Plant walls are frequently subjected to forces and strains above and beyond those usually encountered in public or commercial buildings. Temperature variations due to operating processes may be much wider, affecting both the superstructure and its enclosure. In fact, this factor may loom so large that it is impractical to use anything except a very flexible system. Vibration often dictates special treatment. The necessity for locating plants at specific geographical points sometimes introduces unusual problems in soil stability and climatic changes, both factors in masonry wall stability. The very atmosphere to which buildings are exposed may be contaminating and highly corrosive. Even though masonry is highly resistant to the effect of most chemical fumes, cases have been experienced where brick walls have failed completely from internal build-up of sulphate crystals and allied chemicals.

Many of the above conditions dictate the use of special design techniques. The same procedure may not work in any two similar situations. Consequently, these are special problems requiring special solutions. However, there are two elements that work both separately and together to destroy the integrity of masonry walls and against which specific preventative measures can be repeatedly effective —namely, changes in moisture content and variations in the temperatures to which masonry is exposed.

All masonry is subject to moisture absorption to some degree. It is always affected by temperature changes. Peculiarly, moisture and temperature produce exactly the same dimensional changes—an increase in either or both causes expansion, while a decrease causes shrinkage. Not only that, high temperatures are frequently accompanied by heavy precipita-

tion so that the effect of both temperature increase and moisture absorption takes place at the same time and is cumulative. In addition to these results, dimensional changes in the steel supporting structure resulting from temperature variations exert forces on masonry which create large differential movements. The thermal coefficient of steel and concrete, for example, is up to 2½ times that of masonry. The forces acting on masonry walls, both from within and without, sometimes exceed the masonry's compressive strength while it tensile strength, as well as the bond strength of mortar, is almost always exceeded when reactive movements are developed. A wall which is restrained by its supporting structure or its own mass invariably cracks when shrinkage takes place.

When a wall cracks, return to its original position is cut short. During the second and succeeding cycles of temperature and moisture changes, particles of mortar and masonry units drop into the crack to partially fill it so that, at maximum elongation during the next cycle, the position of the wall is somewhat farther along the support than it was at the peak of the previous cycle. Thus the results of cyclic changes are cumulative. Sometimes, evidence of cracking is difficult to detect because the change has produced short, thin openings distributed over wide areas, but if a wall leaks, they are always there.

Two types of cracking are involved. One is identified by opening of mortar joints at the interfaces of the masonry units resulting in hairline cracks which do not necessarily extend from brick to brick. Such openings form channels for infiltration of water by capillary action. The other kind of crack is recognized (1) by its size which varies from hair line width to that big enough to "lay a hand into," and (2) by its direction and course which frequently is directly through brick without regard to the position of joints, or zig-zag from brick to brick and course to course. The first type is caused by shrinkage in individual masonry units, accompanied by poor adhesion of joint mortar and the use of mortar having high shrinkage characteristics. The second type is caused by shrinkage of whole sections of the walls, together with the results of differential movements restrained by collateral construction.

About three years ago our company initiated a study to find out why we were getting adverse comments on masonry walls from the operating management of some of our plants and to determine the procedures which would eliminate recurrence in our new buildings. Many plants in widely separated locations were visited. The condition of their masonry walls was closely examined and the causes for cracking analyzed. Let me show you some of what we found.

FIGURE 1

Figure 1 shows one wall of the cafeteria building at one of our plants. This building as well as all others at this plant has composite walls with brick facings and smooth-faced hollow tile back-ups in a total thickness of eight inches. Most columns were encased, with the tile or brick in intimate contact with column

FIGURE 2

webs and flanges. Because of the restraint offered by encasement at columns, the walls cracked vertically at each column location. Also note the opening of head joints throughout the wall area. Considerable movement here has resulted from thermal changes and variations in moisture content. Figure 2 shows what happens on the inside of the walls at these locations. Note how the column encasement has sheared away from the wall.

Figures 3 and 4 show much indiscriminate cracking throughout the wall area, particularly in the parapets. The columns of these particular buildings were not encased, so the vertical cracks at column lines did not develop. However, here as well as in Figure I, we can observe the results of poor bond between mortar and

FIGURE 3

FIGURE 4

FIGURE 5

FIGURE 6

FIGURE 7

brick and of movements in the masonry wall itself.

We have experienced much trouble with parapet walls. Both surfaces of these building elements are subjected to extremes of moisture infiltration and thermal changes which cause movements differing from those in the wall below which is exposed on one side only. There is generally a through-all flashing approximately a foot above roof level which acts to separate the parapet physically from the wall below and locates a plane of weakness. This is true, even though the flashings themselves have been designed to promote continuity of mortar bond. In addition, parapets lack the weight necessary to hold masonry units together and maintain integrity. Sometimes attempts are made to protect the inside of parapet walls with flashings extending from the roof to the underside of the coping in order to limit exposure. This technique often proves ineffective. We are just finishing repairs to parapet walls treated in this manner on a laboratory building at one of our plants.

Figure 5 shows how one parapet wall has expanded and bowed outward so that its face overhangs that of the wall below by ¾″. Figure 6 shows how expansion has distorted and displaced the parapets at opposite corners of a building. In this particular case, the wall involved was about four hundred feet long and was constructed without expansion joints. Elongation progressed to the point where an overhang of 2½ inches occurred at both corners.

The forces developed during expansion are terrific. In Figure 7 is illustrated the sill of a door used for loading and unloading purposes, located at the second floor level. The right hand jamb of the frame is positioned close to a four inch jog in the wall, with the column at that point completely encased in masonry. The restraint offered by this combination of details was sufficient to cause the brick in the facing to spall at the sill location as it expanded to-

FIGURE 8

ward the corner. The jamb of the frame offered less restraint and bowed. The wall below the sill buckled while a wide crack developed as the forces sheared the masonry at the internal corner of the setback.

Figure 8 shows another example of results of shearing stresses as a wall about 200 ft. long expanded into a setback.

When concrete foundation walls are exposed to a height of more than a foot or so above grade, thermal changes cause cracking in the foundations. The stresses attendant to that phenomenon are transferred to the masonry above, and it also cracks. Frequently such fractures are erroneously defined as settlement cracks. They are not. Settlement cracks can be identified by their position and by the fact that they are wider at the top or bottom depending upon their location in the foundation. These cracks are of uniform width throughout the exposed foundation height. Figure 9 is a typical illustration of this type of failure. The illustrated masonry crack starts at the bottom of the masonry walls on top of the foundation

FIGURE 9

FIGURE 10

FIGURE 11

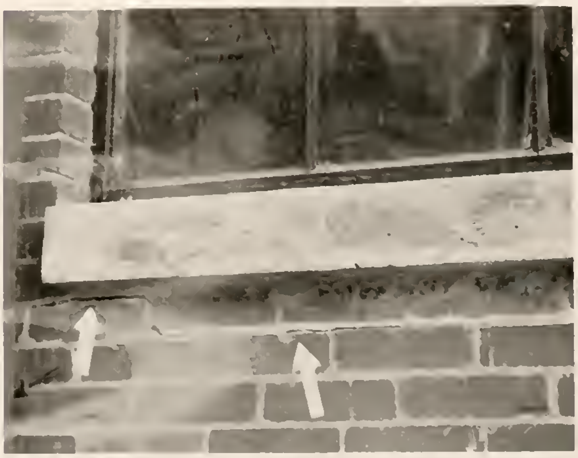


FIGURE 12

FIGURE 13

and disappears at a point about 3 feet above. Figure 10 shows the magnitude of the forces involved: even a 6″ thick precast concrete panel was affected by such a foundation crack.

One of the obscure reasons for masonry failures is illustrated in Figures 11 and 12.

In the first, the walls support a small section of concrete roof slab, poured in intimate contact with the top of the wall. Upon setting and curing, the slab warped, causing ruptures in the masonry at the corners. A similar condition developed under poured in place concrete window sills as shown in Figure 12.

Another type of failure which can be serious is the one shown in Figure 13. We find this happens in most cases where wall-bearing design is used. Cracks develop at the intersection of partitions with exterior walls along both sides of the building. They are wider at the top than at the bottom; in fact, frequently disappear a couple of feet above the floor line. Generally, the roof deck is of poured concrete—either a thick structural slab or a thin slab over bar joists. However, in one case the same thing happened where a metal deck was inadvertently extended into the wall. High summer temperatures cause expansion of the deck, and the movement pushes the load-bearing walls outward at the top. This condition has been observed to progress to the extent that horizontal cracks have appeared in joints located at tops or bottoms of windows.

The extremes to which maintenance work must be carried if we fail to recognize design fundamentals are shown in Figures 14 and 15. The wall in this case was rigidly anchored at one end by an intersecting building unit and

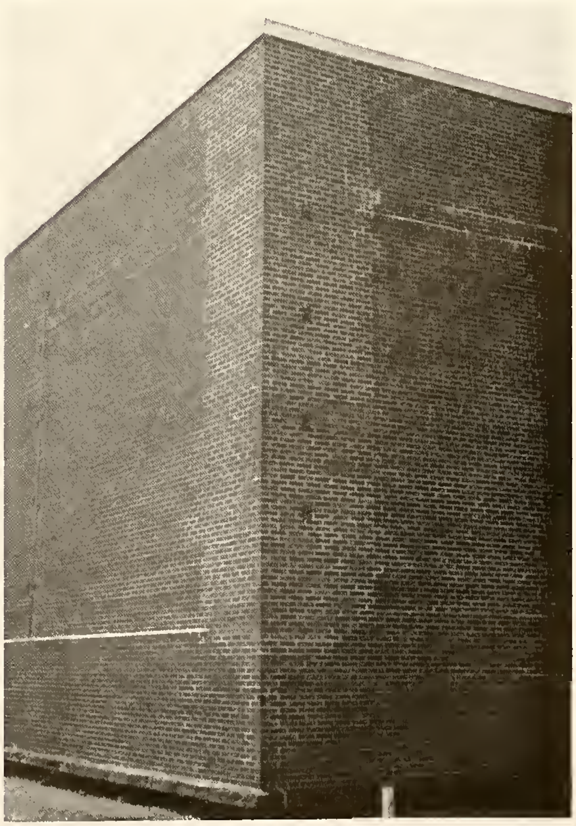


FIGURE 14

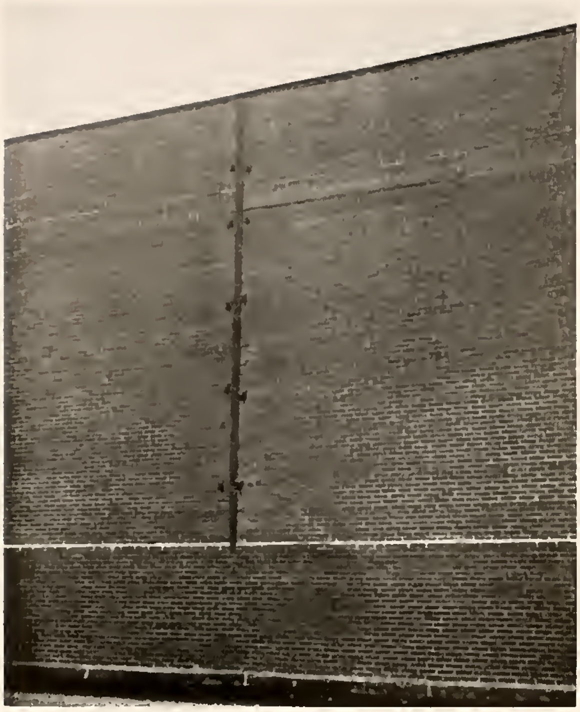


FIGURE 15

all expansion progressed toward the free corner. The columns were all partially encased. Total movement over a period of 10 years was about 3 inches and wall stability was affected. The walls cracked vertically at each column location while the encasement sheared from the inside face of the walls. Figure 14 shows reconstruction work at the corner done about 3 years ago. Note that freeing the walls from the columns and providing an expansion joint has stopped further damage. The expansion joint shown in Figure 15 extends from the bottom of the coping to the top of the supporting spandrel. The cover plate serves only the purpose of preserving the resiliency of the calking compound. Use of the better types of materials now on the market will eliminate the necessity for the cover, if the joint is not excessively wide.

Maintenance Costs and Procedures

When we talk about maintenance work of any kind, the term implies that renewals or repairs of a repetitive nature are involved—that something is necessary to restore or maintain original integrity, that deterioration is anticipated, and results for natural wear and tear.

Can we apply that definition to maintenance of masonry walls? In a broad sense, yes. However, masonry walls need maintenance work *only if* they crack, *if* they or their components disintegrate or *if* they leak. To repair cracks and stop mortar disintegration, repointing is necessary; to obtain additional impermeability to moisture absorption or transmission, waterproofing may be necessary. However, repointing is not done on an annual or biennial basis: it is seldom repeated during an ensuing quarter century. Only in extreme cases is it necessary to rebuild whole wall sections to restore structural stability if expansion has caused extensive damage. But even if such a repair is required, it is seldom repeated during the entire remaining life of a building. The only phase of masonry maintenance that can be properly defined as such, is that of waterproofing by the application of some type of coating to exterior wall surfaces and of replacing calking around the perimeter of openings. Since the advent of silicone coatings, masonry walls are frequently waterproofed immediately after completion with the recommendation that the coating be renewed periodically.

The preceding partially explains why it is so difficult to come up with factual data on maintenance costs. Plant records in many instances are not available to establish costs of repairs which may have been completed 10, 15, 25, or 50 years ago. Also, because of the nature of the failures involved, repetitive yearly appropriations for masonry repairs are not made in the same manner as allocations for equipment maintenance, painting, electrical work, etc. Yearly appropriations for masonry repairs are based on specific requirements, seldom on generalities.

How many of you have ever seen dollars and cents evaluations of masonry maintenance costs? Not many! True, there are unit prices for cutting out masonry joints and repointing, for possibly replacing a section of masonry which failed structurally for some reason or another, for recalking where necessary, or for application of waterproofing compounds. But where have you seen any figures setting forth the cost per year for maintaining masonry walls of, say, $1,000,000 worth of buildings?

During the course of our masonry wall study we made concerted efforts to evaluate costs of maintaining masonry walls. We came up with answers on specific items of repair of recent execution, but data could not be integrated into over-all costs. For example, one of our largest plants, manufacturing heavy chemicals, is composed of buildings up to 50 years of age or more. The masonry walls of its buildings vary greatly as to the kind of masonry units used. Some enclosures have leaked, necessitating some maintenance work but, in general, all walls were performing satisfactorily. An estimate of over-all maintenance costs was impossible and impractical.

At another plant, where materials are compounded for sale to plastics manufacturers, much trouble was experienced with leaky walls. Almost all of the original buildings on the site were involved and upwards of $30,000 was spent, over a period of four or five years, to make necessary repairs. However, performance during the last three years has been good and with an occasional application of waterproofing liquids it is anticipated that a satisfactory status quo can be maintained. The costs here cannot appropriately be ground into a formula which will give over-all results.

In 1948-50, one of our large textile plants was constructed in South Carolina. Its walls were constructed of a single wythe of jumbo brick and were 8 inches thick. Performance to date has been satisfactory and little maintenance work has been required. However, in 1950-52 another similar plant was built in North Carolina and here trouble has been encountered. It was particularly unfortunate for this plant to have been subjected to the heavy wind-driven rains of three successive hurricanes. Eight-inch thick walls constructed of one wythe of hollow masonry units such as jumbo brick are hardly proof against this kind of exposure as you can well guess, but an investigation exposed several faulty details which were the main sources of trouble. Repairs included some cutting out and repointing of joints and cracks, an over-all application of silicone waterproofer and some flashing repairs. Costs of repairs on this $60,000,000 plant have amounted to approximately $20,000 and the need for repetition during the next 5 to 10 years is not anticipated.

If masonry walls have cracked, the most effective repair procedure used to restore and maintain integrity consists of (1) providing flexible fastenings to the supports, (2) removing restraints wherever they exist and (3) to cut in expansion joints at strategic locations. Flexible fastenings will permit freedom of movement without restraint, while expansion joints will prevent cumulative elongation. It is very necessary to provide tight seals at joints in copings (when parapet walls cannot be removed) and at the perimeter of all openings, sleeves, etc. Use of calking materials, such as the new synthetic elastomeric compounds, which retain elasticity indefinitely rather than the use of oil-base materials which dry out and become brittle in two or three years, is a necessity. Waterproofing with silicone waterproofers is a good way of sealing the surface. However, this material cannot be expected to seal openings against wind-driven rain, other than those of inherent porosity or hair-line cracks.

When the faults of any product are discussed, it is necessary for full comprehension

to bring all of its adverse properties into the open. This has been done in the case of masonry walls. However, the over-all picture is by no means as bad as discussion of individual examples seems to indicate. We have built millions of square feet of masonry walls which are functioning satisfactorily.

Conclusions

We are, in masonry construction, dealing with very durable, but also very rigid and inflexible materials. The way in which these materials must be used today differs from that which determined design criteria in the past. Let us start thinking in terms of masonry enclosures, or skins, instead of walls. As long as masonry enclosures must form skins for steel or concrete superstructures, let us treat them as skins. If we accept this viewpoint, recognize the limitations of our materials and design accordingly, we shall have much less trouble. There are some very basic physical laws governing the performance of masonry materials which must be respected exactly the same as for steel and concrete or any other building element which is not purely decorative. We can term observance of those laws, and their application to design of new structures, a form of preventive maintenance.

Some rules which must be followed are these:

1. Recognize that walls undergo dimensional changes and that restraint cannot stop movement. Provide wall stability by using flexible ties to columns, beams and spandrels. Wire or strap ties arranged so as to slide behind a bar welded to columns or beam flanges provide satisfactory fastening.

2. Except when absolutely necessary, do not surround steel or concrete columns, beams or spandrels with masonry. Especially, do not place masonry in contact with columns. Prevent physical contact between edges of decks or floor slabs and the inside face of masonry walls.

3. When spandrels are necessary for support of masonry in multi-story buildings, make them stiff—even to the point of preventing deflection of more than 1/500 of the span and provide slotted connections at one end to prevent cumulative expansion.

4. Provide expansion joints where necessary. They should always be positioned so as to separate building segments or wings and should be strategically located at other points throughout the wall. We have found that the provision of one expansion joint in each 140 ft. of straight wall is quite satisfactory when walls are faced with burned brick units.

5. Eliminate parapet walls. The advent of prefabricated metal facias introduces an excellent medium for finishing off the tops of walls and edges of roofs.

6. Use calking compounds which remain truly elastic and provide lasting adhesion to both masonry and metal surfaces. Such materials, although higher in cost than conventional calking, can be applied at no greater cost than the latter so that the over-all cost is not excessive. A greatly extended, trouble-free life span makes them very economical, indeed.

7. It is always advantageous to waterproof masonry walls as soon after completion as practical.

8. *Keep the walls dry as they are constructed.* This is very important. Do not wet brick unless their absorption rate is very high or unless the weather is very hot. Under no circumstances wet concrete blocks used for back-up or allow them to get wet in storage. Protect the portion of walls laid up in any work period against damage from the elements.

9. Tailor the mortar to be used to the type and the characteristics of the masonry units selected. When the moisture absorption rate

is low, use mortars with higher proportions of portland cement to achieve maximum bond strength. When absorption rates are high, increasing the lime content will prove helpful by providing greater extensibility and water retentivity and promoting better bond.

10. Do a good job of tooling. This means, essentially, that tooling must be done at the right time. Mortar which has not set sufficiently will shrink away from brick surfaces after tooling. If setting has progressed too far the mortar cannot be adequately densified.

In conclusion, let me state that, since we in our organization started to engineer our masonry walls on the above basis, greatly increased water tightness has been achieved and structural cracking has been virtually eliminated. We can unequivocally state that masonry walls do constitute very satisfactory enclosures for industrial buildings when correctly engineered and constructed.

Maintenance of Public Buildings

Charles A. Peters
Public Buildings Service
General Services Administration,
Washington, D. C.

MR. REYNOLDS: *I do not believe there is a man in America who knows more about the operation of buildings than the next speaker, Mr. Charles A. Peters. He is the Director of the Buildings Management Division, Public Buildings Service, General Service Administration of the United States Government.*

Mr. Peters has been employed by the Public Buildings Service and its predecessors since his service with the Bureau of Yards and Docks, United States Navy, during World War I. He is a Bachelor of Civil Engineering from the University of Michigan and a member of the American Society of Civil Engineers, the Society of American Military Engineers, the Illuminating Engineering Society, several code committees of the American Standards Association and the International Municipal Signal Association.

He is also a member of the Washington Building Congress, the Building Owners and Managers Association, Washington Society of Engineers, Buildings Management Association, Government Services, Inc., Federal Safety Council, Federal Fire Council, The Washington and Maryland Societies for the Blind, and the P.B.S. Welfare Service, Inc.

THIS paper is a report of experience associated with 36 years of living with the problems of building design, building construction, and building operation. It represents an effort to record the performance of materials that are basic in the design and construction of public buildings.

It would be highly desirable if we could duplicate the forces of nature and in a matter of days of testing predict the performance of

materials that the architect and engineer will use in erecting their structures. From my experience, I believe we are still limited in our conclusions drawn from tests, and that time and nature's forces still produce the conclusions that are universally accepted.

Having been asked to participate in the Conference on Modern Masonry, I have approached the subject from the viewpoint of commenting on the materials that are used in public buildings to enclose the buildings and to partition the buildings.

The maintenance engineer, probably more so than the architect, becomes conscious of operating costs. He can evaluate mistakes in design practices and quickly observe the defects in workmanship and those resulting from poor inspection. He may take the time to pass back to the building designer and the producer of materials, corrective suggestions or information that would alert them to errors in design or in manufacture. The usual course, however, seems to be to live with the mistakes and to attempt corrective alterations and repairs.

We do review our design practices, such as design details and specifications, periodically. Recently a committee of seven experts was appointed to study and report on the documents, criteria, and practices that establish design and construction standards of public buildings. Their objective was to bring the existing standards in line with good commercial practice consistent with Federal requirements and to insure minimum operational and maintenance costs.

It may be of interest to repeat a sentence from the committee report that relates directly to the subject. The comment concerns exterior facings. "Public Buildings Service should not experiment with any particular type of construction but should use proven materials to assure minimum operational and maintenance costs."

Exterior Walls— Design and Construction

When selecting the materials for exterior walls one thinks in terms of durability, appearance, weather-tightness, unit cost of material in place, and low maintenance cost. There are other factors that are important to the architect, possibly classed loosely as the aesthetic requirements, but to those responsible for maintenance and operation, materials requiring minimum maintenance are ideal.

Granite brings to mind a material that is ageless. It is used today by the architect for a partial treatment of the exterior of a building. It has some disadvantages in today's concept of a public building, and these are weight and first cost. On the other hand, the buildings we operate that are granite faced are practically free of maintenance costs for stone work.

Limestone is the most widely used stone for exterior treatment and when selected for qualities of hardness, surface texture, and resistance to moisture, is on a par with the other materials for beauty in design and low maintenance cost. It is one of the outstanding stone materials for a public building.

Marble as an exterior treatment is one with which we have had limited experience. There are a few public buildings that are marble faced but it is a stone that lends its beauty to interior finishes. Where extremes in weather are not conditions that have to be considered when selecting exterior stone, marble is an excellent stone with low maintenance cost.

Sandstone has been used to some extent for exteriors on such buildings as the White House, the center wing of the Capitol, the Court of Claims, and other public structures. It is most successful in this use when kept painted.

Brick as one of man's oldest building materials is an excellent treatment for exterior

use. We have many brick faced buildings which give excellent service from the standpoint of low maintenance cost. This is one material that requires careful inspection during construction if the building walls are to remain free of water. The entrance of water has been our principal source of trouble and the most difficult to correct. The cause is usually poor workmanship or skimping on the vertical joint mortar. We have examples of this at Suitland, Maryland.

Terra cotta has many qualities to recommend its use in buildings. Its history, however, as an exterior building material, records many instances where trouble resulted from design defects, anchor corrosion, failure to consider climatic changes, and installations that were difficult to reach and maintain. As a man-made material, it readily fits into architectural concepts and can be so moulded.

Concrete exterior walls have not been too well received when considered in public building design. In some parts of the country, concrete buildings for public use have been constructed which are achitecturally beautiful. In the limited experience we have had from the standpoint of maintenance, this exterior treatment appears to have low maintenance cost. Our main difficulty has occurred in designs which did not fully allow for temperature changes and resulting movement in the spandrels. Our Federal Warehouse, here in Washington, is an example.

Stainless steel as an external facing material has not been one of our problems. It is too new and will have to prove itself as a protective skin before it has wide acceptance with architects of public buildings.

Glass in the form of panels or blocks is not a material that has been used to any extent for the exterior treatment of public buildings.

Exterior Walls—Maintenance

Maintenance problems that have concerned us in connection with exterior stonework have been widespread geographically. They result from climatic changes, design weaknesses, poor workmanship, and inadequate inspection.

The materials used for setting and pointing have also played a large part in contributing to our problem, and in some instances the corrosion of anchors has produced major failures.

Poor inspection can be defined in a number of ways, but our experience indicates its cause stems from too much reliance on the workman to conform to design details that are not fully understood, limited funds to hire qualified inspection personnel, and leniency on the part of the men responsible for getting what was intended.

Specifications should include the requirements that will adequately describe the material and assure rejection of faulty pieces. Material inspection is very important if we are to obtain the quality material specified.

Considering stonework from the viewpoint of installation we find that poor workmanship, unsatisfactory bonding materials, and lack of protection of the work during construction are the principal sources of trouble.

The tendency to use high-strength mortar usually results in poor bond with the masonry units. Shrinkage quite often destroys the bond between the masonry units.

Mortar design or formulation has been widely investigated but it still remains the weak point of a masonry-faced structure. Possibly because it is relatively simple to prepare, it remains a point of weakness. Much can and has been written on the subject, still it is the principal cause of the need for periodic maintenance of stone work.

Much greater success has been attained with brickwork than with stonework from the standpoint of mortar design. Here the chief trouble has been the difficult task of trying to get sufficient mortar in the vertical joints.

Where pointing mortar is used, there is a tendency for a crack to develop between the mortar and the masonry unit which admits water. Where a rich mortar is used, the stone on one side of the joint will often spall off.

These difficulties have led to the use of calking compounds in many cases. Calking materials have been and still are relatively short lived in maintaining a perfect seal. New formulations appear from time to time, but the period of effectiveness is quite short when exposed to the sun. Where calking materials are required, they should be used where inspection is easy and repairs can be made without too much difficulty. Design should be such as to eliminate the pocketing of water when the calking material fails.

Waterproofing materials have received careful consideration when we faced the problem of damp walls or walls that permit the passage of water. The materials so classified have a relatively short life before requiring additional treatment. This is particularly true when exposed to the sun. I am of the opinion there is still no short cut to a weather-tight structure except by the use of sound materials, skillfully placed and designed to develop their full capabilities.

Metal skins, when they become accepted in the same sense as we accept stone-faced structures, will bring their own problems of maintaining a weather seal.

Glass panels and blocks offer features that will intrigue the architect and may be used more extensively in the future. Whether they will solve the problem of maintaining a weather-tight building and one which will be economical to maintain and operate, remains to be seen.

Exterior Problems

When considering exterior problems we all agree that the parapet wall is our principal offender and produces more troubles than any other part of the building. Since the parapet is more exposed, it is subject to greater expansion and contraction than any other part of the building. This problem of expansion, together with flashing difficulties, means leaks, water infiltration, freezing, anchorage failure, and masonry cracking and displacement.

The solution is only possible through the most careful consideration in the design and construction of the many details involved, with very special emphasis on expansion. We believe the best solution, where possible, is to omit the parapet and our present revised standards so provide.

An example of this problem occurred in the Seattle Court House where the exterior terra cotta facing of the building has been seriously damaged, water getting in through the parapet due to inadequate flashing and counter-flashing. The moisture has penetrated the exterior wall, causing discoloration of the terra cotta and leakage on the interior ceilings.

The problems that develop through improper anchorage or failure of anchorage, usually through corrosion, are many and their correction is very costly. I could sight many examples but the following three in different types of masonry will illustrate the problem.

In the Cleveland Post Office the exterior fluted stone pilasters, through improper anchorage and support, came loose and some were projecting due to frost action. Since large stones were involved high on the exterior face of the building, a very expensive job of resetting and anchoring resulted.

In Dallas, Texas, the brick pier facing between the 14th and 15th floor levels of a 19-story building fell on the roof of an adjacent 3-story building. It was found that the brick facing was improperly anchored to the structural framework. The cost of rebuilding and settling claims was in excess of $200,000.

In Chicago the three upper stories of the America-Fore Building were faced with terra cotta. Water entering through the joints cor-

roded the anchors and several large sections fell to the street below. Luckily no one was injured, but the entire three stories of facing had to be removed and replaced at a cost of several hundred thousand dollars.

If stone walls are to be kept tight, a planned program of exterior pointing and calking is necessary. Careful inspection is needed to determine how often this must be undertaken. We have not been able to develop a formula that would apply since many factors, including exposure, size of stone, type of joint, kind of stone, and quality of original work, all play a part in the life of pointing and calking. We have found that most structures will require some pointing at least every ten years and some calking every three years.

Strange as it may seem, we have had to repair damage caused by lightning. One example is the General Services Building where several hundred dollars in damage resulted on two occasions from strikes on the parapet wall. Buildings like the Washington Monument and the Lincoln Memorial have elaborate lightning rod systems properly grounded to prevent damage.

Time will not permit my covering many other problems, such as that introduced by birds roosting on buildings, but they are many and varied.

Interior Walls—Construction

Interior construction problems that occur from occupancy changes are usually the result of organization changes in the tenant agency. The day is gone when the architect can firmly plan on how the interior space of a public building will function. Very often before the contractor has completed his work, changes are called for that are costly. Why, you may ask, is this permitted? The reasons for the changes are usually sound and functionally desirable. Recognizing this situation, it is necessary to plan carefully the use of interior partition materials.

Since weather is no longer a problem with interior walls, the bonding materials are not too critical. Maintenance is minor, and the more costly materials can be justified on the basis of permanency in many locations. When repairs are necessary, the cause is abuse or faulty workmanship.

Materials such as marble, limestone and brick can be used in constructing main corridors, elevator lobbies, service and mechanical areas. Our experience indicates that marble has decided advantages in lobbies and main corridors.

Marble is very attractive for such use, requires very little maintenance, is easily cleaned, and will stand reasonably hard service. Why people abuse interior walls by placing their feet against them, writing on them, or otherwise defacing them is hard to understand, but they do, and marble surfaces will take that abuse without serious damage.

Granite can be used where damage is quite probable or service may be very severe. Glass block and glass panels are desirable in some locations because of low maintenance and cleanability. The same is true of terra cotta for floor surfaces and for decorative treatment in corridors, lobbies, auditoriums, and public areas.

Interior Problems

Speaking of tile floor surfaces reminds me that the design and construction details must be planned to insure low maintenance and operating cost. An example of the wrong solution exists in the Interior Building, here in Washington. The joints between the floor tile are about ⅜ of an inch wide and were slightly depressed to allow for any irregularities in the surface of tile.

The result was a very attractive floor but, when we began to clean the floor with a power scrubbing machine, we found a serious defect. The machine which uses a squeegee to remove the water would not pick up the water from

the joints. This resulted in the use of a second man to mop behind the machine, thus requiring two men to do the job instead of one, and doubling the cost.

The type of material to be used for interior partitions dividing the office space into rooms has received a great deal of study from the operating man in recent years. We have used masonry partitions, metal and wood ceiling-high movable partitions, low-height movable partitions, and the dry-wall type of partition. We have sought a low cost solution that would insure maximum flexibility.

We have about concluded that there is no one solution for all buildings and all types of occupancy. We find that each problem requires study. In some types of occupancy, we found that we did not move partitions as often as was expected. Some tenants could use the low-type partition with good results while this type partition completely disrupted the work of other agencies.

Operator's Viewpoint

From the viewpoint of the manager and operator of public buildings it is very important to know materials and to observe how they were specified to be used by the architect and engineer. This knowledge can be particularly useful when repairs, alterations, and maintenance problems are resolved. To observe weaknesses in design details and specified materials is important. Suggested improvements will be particularly helpful to the design office to prevent the repeating of mistakes.

Previously I referred briefly to the special committee of experts and their misson. The operating people worked with that committee when they reviewed specifications and design details and directives, which required changing, to correct faults and improve future designs.

Too often the architect has the view that the tenant should be satisfied because the architect knows best. As an operator, I quickly learned the tenant had ideas of his own. Many improvements that develop lower operating costs originate from tenant suggestions or from the operating organization.

Costs

Operating costs of Federal buildings are subjected to careful review by the Bureau of the Budget and by the Congress. The continuing study to arrive at still lower operating costs challenges the ability of the operator. In searching for the means to accomplish this objective without cutting service, the operator must focus his attention on the materials of which the building is constructed as well as on the design of the building itself.

Because a Federal building has an indeterminate life, that is, it is not planned and not constructed for a specified number of years, new materials are subjected to searching inquiry before they can replace materials that are "time proven." This may be disturbing to some manufacturers but it is necessary. The architects that design Federal buildings are aware of this when they create their design. It does not mean the absence of progressive construction or ignoring new concepts in design, but it does mean the use of the building materials that have withstood the test of time in public buildings.

Maintenance costs of specific materials are very difficult to tie down because they do not occur annually. When failure takes place due to faulty design, poor workmanship, or the presence of materials that should have been rejected, costs that are sizable in amount may occur. Even here, they are so scattered geographically and by years, that the costs are usually not a large part of the operating budget but are certainly an unnecessary part which we would like to eliminate.

Discussion

MR. REYNOLDS: The first question is addressed to Mr. Noyes. It reads "$1.22 for tilt-up wall. Does this include sash and equipment, surcharge for lifting?"

MR. NOYES: It does. It includes the tilt-up section—it includes the corrugated asbestos, which was used as dividers between windows and above the windows, and it includes the sash itself and the glass. It was a complete wall for that purpose. There was no interior finish, there was no fanciness to that wall. It was a straight industrial wall.

MR. REYNOLDS: The next question is to Mr. Peters. If we omit the parapet, how do we handle sudden heavy rains, common in southeastern states?

MR. PETERS: We could accomplish that through the design of the roof in directing the water to suitable downspouts, either sloping the roof to interior locations or gutters that would be of ample size. It is usually done by sloping the roof to interior downspouts.

MR. REYNOLDS: The next question is to Mr. Myhre. What is the relative importance of moisture and temperature movement? What is the order of magnitude of moisture expansion in brick walls?

MR. MYHRE: Well, that is a little difficult to answer. It seems that there are no data that I have ever seen that have set up the results, or that have graphically set up the results of moisture absorption or expansion from thermal changes. We do not know that as far as thermal changes are concerned, there are figures which vary all the way from, I think it is, .000003 to .000008 inches per foot.

MR. REYNOLDS: The next question is to Mr. Noyes from Mr. Reardon. Is reinforced brick masonry used extensively on the west

coast for single-story construction? How does it compare with (a) tilt up, (b) poured in place concrete, (c) gunnited walls?

Mr. Noyes: I'm afraid I cannot answer that. I have no connection with the west coast, my experience is entirely on the east coast, and we have not used reinforced brick work to its full extent. We have reinforced odds and ends here and there, but not to any great extent.

Mr. Reynolds: Now, here is a question from Mr. Reardon of G.E. to anyone, but I'm going to address it to Mr. Myhre, because we were talking about the subject before the session began.

If mortars are such an important part of the masonry wall, I would like an expression of opinion on masonry cements versus portland cement—lime putty, or hydrated lime.

Mr. Myhre: I don't think I have ever been in a conference or in an assembly of engineers and architects where that question has not come up.

I am going to give you my own personal opinion. Now, this can be taken for what it is worth, and it must be considered my personal opinion and not reflect on anything that anybody else is connected with.

I think that high lime mortars are the most effective mortars. I do not think that masonry cements consisting of portland cement and ground limestone will be suitable in most cases. I think that masonry units having a low moisture absorption characteristic could very well use that type of material. However, when the absorption rates become higher, we need the qualities that lime can produce in the mortar, and very few masonry cements use lime, that is hydrated lime, in their masonry mortar.

Mr. Reynolds: The next one is for Mr. Noyes. In your opinion, can money be saved in one- and two-story buildings—schools, offices, etc.—by using load-bearing masonry rather than frame structures?

Mr. Noyes: Our experience with frame structures is rather meager in recent years. I don't think this question can be readily answered. Many factors have to be taken into account, such as maintenance and various other angles. I believe that frame would be cheaper, but I don't think it would be as satisfactory.

Mr. Reynolds: I have two or three more questions of Mr. Myhre. Here is one from the Dow Chemical Company. "What type of waterproofing do you recommend? What material do you use in expansion joints?"

Mr. Myhre: There is only one waterproofer that is satisfactory in my estimation and that is the silicon waterproofer. None of the other waterproofers will approach it in sealing the pores and hair cracks in masonry walls. I know Dow makes that material as well as General Electric. We do not.

Now, there are new truly elastic or synthetic materials on the market today which are a great deal better than the old oil-base type of calking compounds. I am referring to such materials as glycol. We ourselves are developing one that we think will do the job at a little bit less money, possibly, than glycol. But these materials will last a great deal longer than the old compounds—four or five times longer, in our estimation. We have tested them for three or four years now and their condition is almost the same today as the day they were applied. We think the world of them. It costs a little bit more when you first apply it, but the over-all cost is much less.

Mr. Reynolds: Now, Mr. Myhre, I have two questions here which I am going to combine into one.

The first one is can you describe the expansion joint or control joint as shown in your last slide. And the other one is what is your recommendation in regard to the use of through-wall control joints, in addition to expansion joints, for controlling cracks in long masonry walls.

Mr. Myhre: When you have walls consisting of a brick facing or some type of hollow masonry unit, we will say, for back-up, the type of joint is almost automatically designed. Of course, it must extend all the way through the wall. It cannot be just through the facing. We generally place them on columns, so that both sides of the wall can be supported with flexible ties to the columns. The joint is usually three-quarters of an inch wide as a minimum—maybe a little bit more, depending on the length of the wall. The joint is sealed with an elastic, very elastic, material, such as sponge rubber, or something that will come back again when the wall shrinks, and is sealed on the outside surface at least with a calking compound. Now, if the old type of calking compounds were used, and that was the case in that last slide, it is necessary to protect that compound from the weather. And that was the reason for the plate that you saw, which was fastened only on one side. It kept out the rain and the sun and would make the old type of compound last that much longer. We don't think they are necessary with the new materials.

PART FIVE

Building Type Analysis

PRESIDING CHAIRMAN:

Walter A. Taylor

Director,
Department of Education and Research,
American Institute of Architects

MR. SILLING: In an earlier year, the next presiding officer was a missionary in China. He has practiced architecture in New York, in the Grand Central Station—a noisy place for such an endeavor.

Mr. Walter A. Taylor is the Director of the Department of Education and Research of the American Institute of Architects. He is also a representative of the AIA to the Building Research Institute and is a member of the Executive Committee of the Building Research Advisory Board.

Mr. Taylor began his career as a resident architect and engineer in the Central China University in Wuchang, was an architectural engineer with the Los Angeles Board of Education, practiced in partnership in New York City, and has been a lecturer and professor of architecture at Syracuse and Columbia universities.

He has a Bachelor of Architectural Engineering from Ohio State, a Bachelor of Architecture from Columbia, and a Master of Architecture from Ohio State. Besides his membership in the American Institute of Architects, he is a member of the American Society of Engineering Education, the American Association of University Professors, and the Society of Architectural Historians.

Residential Design

S. Robert Anshen
Anshen & Allen,
San Francisco, Calif.

MR. WALTER A. TAYLOR: *It seems to me that we might have had another title for this Fifth Session. It might be called Masonry in Contemporary Design. I don't think any one of these architects on the panel would like to be called traditional. I know they are doing some very interesting work.*

I hope you notice that the speakers are listed in alphabetical order, so there is no implied preference as to building type or architect.

Our first speaker is S. Robert Anshen, who is a vice-president and partner in the firm of Anshen & Allen. He has been winning AIA Honor Awards with embarrassing frequency. He is doing some very interesting work on the west coast.

Mr. Anshen has Bachelor and Master of Architecture degrees from the University of Pennsylvania, and studied under a Stewardson Travelling Fellowship. He is a member of the American Institute of Architects and Sigma Psi, an honorary engineering fraternity. Recently he was a lecturer in design at the University of California College of Architecture.

I AM very happy to talk about masonry in connection with houses, because I think we have used far too little of it. I don't think that any discussion of houses is complete without recalling what Xenophon said that Socrates said about how a house should be built. You have all heard of solar houses and various different kinds of houses. You no doubt know about a certain magazine which has gotten very fancy climatologists and weather experts and what-not to tell us that we should not put houses where the wind is going to

disturb them or where flash floods are going to hurt them. And there is a very costly program of selling the American public on the fact that the sun rises in the east and sets in the west.

I was glad to hear Mr. Noyes mention the east and west sides of vertical buildings, because it has always been a mystery to me why most skyscrapers built have the same facades on the north, south, east and west.

Back to what Xenophon said about what Socrates said about how a house should be built. Socrates, resorting to his usual question and answer method, asked, "Should a house be a pleasant place to live in and a safe place to store one's belongings?" When this question, too, evoked no disagreement, he said, "Well then, should a house be cool in the summer and warm in the winter?" When this question, too, evoked no disagreement, he said, "Well then, if you build the north side low and the porticos high and facing south, the building will be protected from the cold in the winter and, in the summer when the sun is high, it will cast shade and it will be cool, but in the winter when the sun is low, warm. If, then, these are desirable characteristics, this is the way to build your house."

Today there is probably no more complicated building, for its size, and for its relatively simple use, than a dwelling. We may forget that our early houses—take a New England farmhouse, for example—had simply four rooms with a chimney in the center containing three or four fireplaces so grouped as to face into the four rooms. One of the fireplaces was the kitchen stove.

Ladies and gentlemen, there was no inside water, no kitchen sink, no insulation, no washing machine, no dryer, no refrigerator, no disposal, no dishwasher, no ironer, no air cooling, no interior plumbing, no vacuum cleaner, and no light, except for a candle or oil lamp. Today, if we built only as much into our houses as our forefathers did into theirs, they would cost approximately 27 percent of what our houses now cost and shelter would be one of our cheapest commodities in relation to food, clothing, etc.

However, the difference in houses of today and those early ones represents one of the great symbols of the civilized advance of our time. It cannot be stated too basically or clearly that mass production, and thus the mass use of delicate and fine products to lighten the labor of mankind (to say nothing of womankind), is the hallmark of our advancing civilization.

The difference between the early house and the house of today means the difference between a slavery-in-drudgery, and emancipation to a life of ease and leisure.

Leisure through all time has been the basic requirement for the flowering of culture in any civilization. You cannot address your mind to the stars, to inventions, to poetry, to the mysteries of the universe, if all your time is occupied in getting your food and cleaning your nest.

Thus the concept of the house is simple, as expressed in colonial times, but has indeed become now the repository of some of that vast body of applied science and myriad intricate skills and invention, which lead to a successful realization of advance toward leisure, and thus a higher culture.

Continuity of history combined with vigorous advances in the development of new materials, the better use of old materials, the imaginative, bold advances in techniques, was only begun.

Our best products, man made, come from the research integration, variation and mass production of material things.

How does this affect the use of masonry? To begin with, modern power tools and techniques of handling age-old materials have changed our use of these materials. Not so very long ago even kings could not afford such luxurious selections of materials as can we

today. Now heavy materials can be hauled thousands of miles by ship and rail at a fraction of the cost of hauling them a few miles a short time ago.

Which materials are at hand with which to build depends upon how far we can reach, not only in space but also in time. Advancing civilization makes available new uses of existing materials and existing materials in new uses.

As we progress, we are wise if we make full use of new ways of using old materials and old ways of using new materials. For example, fireplaces have been superceded by more efficient methods of heating, but everyone should have one, of masonry, and everyone wants one of masonry because of the simple delight of looking at the fire burning on the hearth. What atavistic impulses may activate us in observing the fire burning on the hearth I do not know, but I do know that it is an important part of life—a part not to be missed. It may be that the flickering light has the variations of nature, pleasing and soothing to the eye, as opposed to the monotony of artificial light.

In houses, as elsewhere in architecture, masonry is used because in certain areas it is the only material available which combines the requisite properties of strength, durability, insulation, weatherproofing and a rich texture or finish. Man-fabricated materials, which compress the strength and insulation of a two-foot thick stone wall into a few inches and which come in large sheets, easy to erect, cannot be used as yet in certain areas because they have not been developed in finishes which give the proper life and depth of texture.

We must reverence the fabulous genius of mankind in the introduction of steel, aluminum, etc., which are made under heat and pressure, much as the minerals and oils, which were created in geologic time, were made by nature under the heat and pressure of cataclysmic changes in the earth. Plywood, plastics, glass—these materials do not exist in nature. They are wonderfully created by mankind for his greater convenience and in order to make his architecture greater. The advances which mankind makes in altering natural materials to alter his environment to suit himself have only begun. But it is not only new materials, but the more effective use of old materials which stirs the imagination.

Stone is as old as the hills. Masonry is the material which mankind instinctively thinks of when he considers historical works of art in architecture. Psychologically, masonry in a building conveys a sense of permanence, of its having been "alive" when our forebears were living and of its survival, through the vicissitudes of generations to come. Countries where proper pine forests grow—United States, Norway, Sweden, Finland, etc.—are "lucky." They never existed in Spain or Italy.

It is evident that "newer" countries, where there are ample supplies of suitable wood available, use a great deal of it, particularly in the construction of houses. Older countries have more traditionally used masonry. This is a matter of expediency, cost and getting something built fast. The American frontier from east to west could never have been conquered with such incredible speed if it had not been for the "temporary" use of wood for construction. The fact that wood is relatively non-fire resistant, subject to the attack of insects and vermin, highly costly to maintain, is lost in the exigency of the lower initial cost.

It is to be observed that mankind generally takes better care of its goods and material possessions than it does of its human resources. Thus factories and warehouses, counting houses, temples and churches have been constructed of masonry while dwellings have been made of lesser materials. If there is a fire, theoretically, human beings can move away

from it, but goods and possessions must be protected by strong walls and heavy doors.

Houses are the last buildings in our age to receive the benefits of the best building techniques. Good planning, good plumbing, good heating, ventilating, lighting, design come last to houses in our civilization. This is also true in ancient civilizations.

An industrial or commercial owner will expend untold energies and treasure learning how best to construct buildings for his plant and equipment. He will experiment and objectively weigh the pros and cons of new and old methods, materials and techniques. His mind and his architects' minds are free to weigh the catastrophic results of calamity versus first cost.

This is not so of the house-building owner. He is first concerned with an amazing array of intangible concepts which go deep into his early life and make him view his dwelling in a confused haze of history, custom, family background, keeping up with the Joneses or conformity to the current usage in the particular economic class he happens to be in or wants to get into. If he has a half a million dollars to spend for his dwelling, he wants a million dollars worth of dwelling. If he has $10,000 to spend, he wants $25,000 worth of dwelling.

In costly custom built houses, the architect frequently can employ the use of fire-resistant materials, of which masonry is, of course, presently the most satisfying. However, as we go down the economic scale into 50, 25, 15, 12 thousand dollar dwellings, masonry becomes harder and harder to use. We wind up in a $12,000 house with a $270 fireplace, probably made of brick. This is true of the entire country, except in some eastern and midwestern metropolitan areas.

Since the vast majority of houses built since the war have cost from $15,000 down, this poses quite a problem and the fault must be principally laid at the door of our national concept, of cheap temporariness. This, I think, stems from the early pioneering necessities of getting things built as cheaply and as quickly as possible and is terribly, ostentatiously—while principally subconsciously—reflected in our national regulations regarding how houses may be built.

Low cost and speed were necessary in the pioneering days. Today they are causing fantastic waste of opportunity, treasure and natural resources.

The F.H.A. and the V.A. insure mortgages on most of the houses built today. Their power to control design, materials and methods of construction are, from a practical point of view, almost limitless. As insurance companies, they have stockholders, in this case the American public, and they are even more cautious and bent to current tradition than private insurance companies, if possible. The architect, the builder, has to conform to their ideas of what a dwelling should cost. Their tables and statistical data are all based on the way we have been building, prinicipally in wood.

If the architect has a project for, say, one thousand $15-20,000 houses he is forced to employ wood principally, or the buyer for such houses cannot afford to buy them. The agencies will not say *not* to build of masonry, but they will appraise principally as though wood were to be used because their basic data for appraisal are the size of the dwelling and the number of rooms, rather than the quality. Thus we are rapidly building these vast potential suburban slums which without the necessary maintenance—which they are not going to get—are now creating the necessity for vast surburban redevelopment commissions.

To rearrange properly the mess we are now creating will cost our children billions of dollars.

If someone or some group could affect these

insurance agencies sufficiently to allow their appraisals to reflect the cost of fire resistant dwellings, great strides could be made. But when I say this; the decision as to the necessity for fire resistance must be sufficient to put an advantage in the hands of a citizen who builds such dwellings.

Let me go into some figures here.

In a typical house which now sells for $16,-200, here is the rough breakdown:

Construction Cost	$ 9500.
Land and Improvements	3000.
Miscellaneous fees, construction money, overhead, etc.	1200.
Profit	1000.
Financing	1500.
Selling Price	$16,200.

Thus the actual dwelling—the end product—costs about 58% of the total cost. If its cost were raised 20% or $1900 in order to make use of masonry construction, the end package would cost $18,100 or a little over 11% more than it does now.

Compare this with a necessary budget increase of $1500 for money alone due to the rise in interest rates in the last two years. No one asks whether it is appropriate to increase the cost of a house $1500, or approximately 10% to pay the banker, but if you try to increase the quality by the expenditure of a similar sum for masonry you are absolutely stymied. The reason I speak of money in addition to appearance and psychological and aesthetic gratifications is that, all rumors to the contrary notwithstanding, handsome, satisfying buildings cost more than others. Architects have done and are doing wonders with the materials and budgets at hand, but in city planning and achitecture it is idle to separate costs from results.

Now, there has been a great deal of talk about "temporary" buildings and how our modern age changes so rapidly that permanent structures should not be built. It is said that each American family changes its abode every seven years, obsolesence take place rapidly, etc.

There is an unfortunate tendency in the United States to relate houses to automobiles in the public, and even in some professional minds. An automobile is a temporary contraption and the reason for this is that it moves from place to place. A house does not and should not move. It is related to a garden which takes years to grow to a satisfactory state of maturity. The only thing about a house which is temporary is its mechanical and electrical equipment which can be renewed through the years if the shell is considered as a permanent, abiding structure.

Even though Americans may move every seven years, they do not build new dwellings when they move. How attractive would our legacy to our progeny be if we handed down to them beautifully arranged fire-resistant dwellings with the patina of time on the walls and roofs and surrounded by old, well kept gardens.

One of the prinicipal ingredients of beautiful architecture is contrast. While architects are thrilled by the new developments in glass, steel, plastics and aluminum because of their light weight, their beauty and the real advances in design which they make possible, masonry, nevertheless, is the only material in existence that makes possible the proper contrast, balance with the newer materials. Masonry is the textured tie with the past and the future which itself becomes more beautiful used in juxtaposition to the newer materials, and makes the newer materials more beautiful by its presence with them in architecture. A building which combines the use of masonry with light metals and glass is more beautiful than just a masonry building or just a metal and glass building.

Above I have been speaking of solid masonry walls. The whole area of veneers has

not been touched upon, and this is a subject of great importance to masonry. Masonry veneer is a beautiful and wonderful thing as long as it is properly used. Architects know that the proper way to use masonry veneers is to express the fact that it is a veneer. It is incorrect to use masonry veneer in imitation of solid masonry. This is the same principle which makes it incorrect to use plastic in imitation of tile, synthetic paper products in imitation of brick, etc.

This produces a dilemma, particularly in houses. Many houses are made of wood with masonry veneers and their builders point with pride to the fact that they look just like masonry and you don't have to paint the outside. This kind of fake is particularly bad and we have a firm rule in the office that masonry may never be veneered onto wood frame construction. The practical reason for this is that a thin veneer of masonry on wood is unsafe in earthquake and is fire-resistant from the outside only. More fires originate in the insides of dwellings. The fake and sham of veneer on wood is to be avoided.

Masonry veneer on masonry structural materials, however, is a beautiful thing as long as it expresses itself as veneer.

Mr. Henry H. Saylor states in his Dictionary of Architecture that masonry is "that branch of construction dealing with plastering, concrete construction, and the laying up of stone, brick, tile, and other such units with mortar." Too little use is made in houses of the art and artistry which can be obtained by the use of ceramic veneers, tile and marble. The integration of other arts with architecture is sadly lacking in our time. The color and texture which can be added to a building by way of designs with the use of these materials is infinite and too little explored, particularly in houses.

Even wealthy people hesitate, for some strange psychological reason, to spend vast sums of money on a dwelling. It somehow seems wrong with our puritanical background to overly embellish the spaces in which one spends one's life. People will travel and spend vast sums in order to see the wonders of the world but they don't want to spend an extra $50,000 or $100,000 for integral color and integral decoration which would be possible by using the great artists of our time to accomplish this. Marble is one of the most beautiful materials in existence and it is rarely used in houses, principally because it might give the idea of ostentation to one's neighbors. When one is rich, it is just as ostentatious to pretend that one is poor, as it is ostentatious for one who is poor to pretend to be rich.

We believe that one place in houses where masonry will be used to a greater extent in the future than at present is in the kitchen. Designwise, the American dwelling is becoming more simplified and direct. Most dwellings are still built in imitation of the days when everyone had servants who lived in. This mystic hangover from the past is still present in the basic plan of the so-called central hall plan. This generally means a postage stamp size house with a tiny hall, a tiny living room, a tiny dining room, a tiny kitchen and a tiny den.

The impact of easy, servantless, informal living in moderate climatic conditions is making itself felt throughout the country now. More and more people are willing to allow the facts of servantless life to make an impact upon the plan of the house itself.

We are now building houses which have a great living-kitchen-recreation-television room as the core of the house. In this room there is a fireplace, barbecue—masonry of course—kitchen equipment, television, sofa, chairs for reclining, as well as dining. Then there is a small, quiet room, also preferably with a fireplace and with a door that shuts out the noise

of the big room. Then bedrooms and baths to taste.

More and more we are developing dwellings which form a pleasant background for the living of the individuals in them. The individual must have individuality, the person personality, not the house or room, except insofar as it, with gentleness and strength, forms a simple background for the activities of the individual and family.

An objective view of the development in houses in this country leads to a recognition of the value of the technological advances in equipment of houses set forth above. That same objectivity leads us to recognize the appallingly poor design which characterizes most dwellings built since the war. (This is also true of most of those built before the war.)

There is a strange dichotomy between the great and careful attention paid to the equipment in American houses and the general disdainful ineptitude of the design of their structures.

This extremely poor design is characterized by the most elementary kind of mistake. Disregarding the generally poor proportions of the buildings—one facade will have three or four different sizes of windows and doors—head and sill heights will be different. This is the result of a myopic view on the part of the builder who is generally used to looking at only one thing at a time. More than 90% of the builders do not use architects at all.

Another objective view shows us that site planning results from a concatenation of all sorts of obsolete rules and regulations, few of which were designed to affect such a situation as has obtained since the war.

Prior to World War II, the majority of houses were built on land which was "developed" by a subdivider. He then sold these "lots" either to a builder or owner who built houses on them. Thus the rules and regulations were made to make a nominal size of "lot," no one knowing what kind or size of house would be put on them at a later date.

Since the war the builder and subdivider in most parts of the country were one and the same person. Thus for the first time in history it is possible to design the subdivision knowing exactly what size of house will go on which particular piece of property. It is possible to vary the volume and size and price of houses which are adjacent to each other, thus overcoming the awful monotony, the fantastically awful monotony of most of the subdivisions built since the war. That this has not been done has been a great failure on the part of builders and architects. Our subdivisions do not make any provision for the grandmother and grandfather who wish to live in a small house not too far away from their children and grandchildren.

We are particularly blessed in America with the vast quantities of beautiful materials readily at hand to be used. We have architects and builders of great skill. If we could realize, as a nation, that we have these vast resources and that we ought to use them, money to the contrary notwithstanding, in order to create, wherever we build, a Shangri-La of beauty, charm and satisfaction, we could do it. It needs but the will for its accomplishment. We have everything else.

Multi-Story Buildings

Robert F. Hastings
Smith, Hinchman & Grylls, Inc., Detroit, Mich.

MR. TAYLOR: *Thanks very much, Mr. Anshen. I will attempt to abuse my position as moderator to make a comment. Mr. Anshen went back to Socrates. Our chairman tried to put me back in Ancient Greece. I would only go as far back as Pliny the Second, and I think anybody who essays to design for climate and be really functional ought to read his description of his villa, where he anticipates many of the things that have been mentioned and are talked about, including the question of a private room away from the noise of the household.*

It would seem that, in respect to a certain element of the population, Mr. Anshen is going to modify the phrase "keeping up with the Joneses" to "keeping down *with the Joneses."*

Now, to get on with our excellent panel here, our next speaker is the vice-president of Smith, Hinchman & Grylls, Inc., one of the oldest and one of the most eminent firms in the country, located in Detroit. He had his special training at the University of Illinois. He has a great deal of concern for the practical and technical aspects of the work produced in that office. He has been very helpful to the AIA in connection with the Committee on Expansion of Schools which served the entire industry by improving the training of consulting engineers in the building field.

DIGGING into the archives of Smith, Hinchman & Grylls, prior to 1929, we found that three of the skyscrapers designed by that firm furnished an excellent example of the type of thing that we are attempting to discuss here today—primarily, stone, brick and terra cotta finishes.

The 46-story Penobscot Building, done in limestone, back in 1927, is characteristic of the type of structures that one would expect

to see in those days. Notice the double-hung windowing set back from the face of the stone some eight to twelve inches.

The Buhl Building, in Detroit, is laid out and planned in the from of a Latin cross. This gave us a very efficient type of building, and the plan was permitted by the dimensions of the site. It was done in 1923 and is a terra cotta faced building. The owners have done an excellent job in keeping it up. They have gone over it very thoroughly two or three times. They have had to replace some of the stones, but in general it has held up very, very well.

The 40-story Union Guardian Building, now called the Guardian Building, in Detroit, was done in brick. There were brick spandrels and metal spandrels used at the various story heights. There was also a lot of very colorful

PENOBSCOT BUILDING

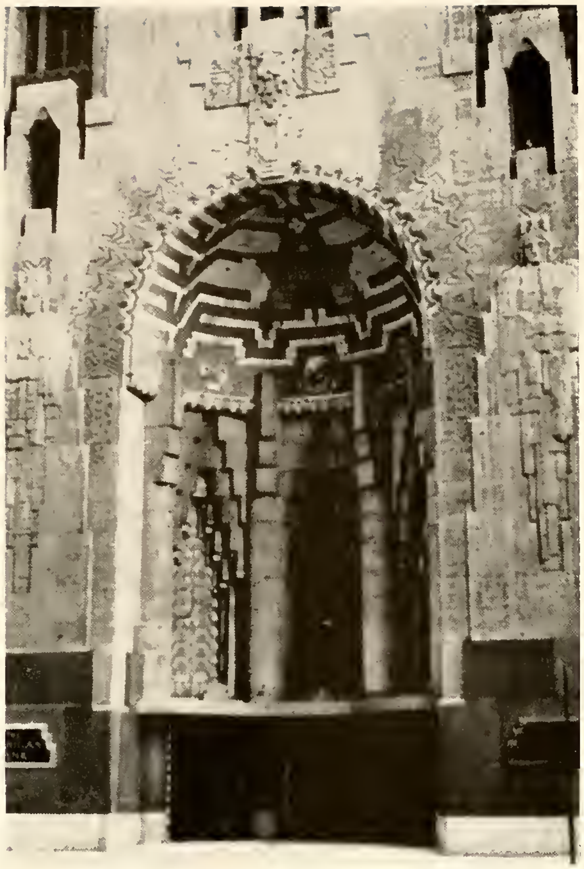
BUHL BUILDING

terra cotta used where necessary in order to give color and atmosphere to this building. It is almost unbelievable that the same person designed this who designed the Penobscot Building. That was our good friend Bert Rollin, who was chief designer of our firm at that time. This building is perhaps the most colorful one of the three, due to the use of the warm masonry materials, including brick and terra cotta.

The entrance detail illustrates the colorful feeling that the designer put into the building, as well as the use of the various types of masonry materials. Note the character of architecture going back to the forms and color used in Aztec architecture.

The Federal Reserve Bank Building addition, done twenty-two years after the Union Guardian Building, was Detroit's first major

UNION GUARDIAN BUILDING



UNION GUARDIAN BUILDING ENTRANCE

FEDERAL RESERVE BANK BUILDING ADDITION

downtown office building built after the depression. It is a very daring departure from the more or less conventional downtown buildings done in the twenties. The designers departed from the method of construction of the twenties and used a prefabricated curtain wall. It is an addition to a marble-faced building, very classic in achitecture. The building has been set back from the property line, rather than providing a court at the rear.

For the walls of this building we used a 1½" marble spandrel backed up by two inches of foam glass and alumafoil insulation. These panels, in turn, are set in stainless steel frames, both vertical and horizontal. The Thermopane glass is brought forward more or less flush with the marble spandrels themselves.

During this same period that the Federal Reserve Building was being designed, Smith,

STEVENS T. MASON BUILDING

Hinchman & Grylls designed the Stevens T. Mason Building at the Michigan State Capitol. This is an eight-story building containing approximately 250,000 square feet—typical, flexible office space that you would expect to see in a capitol development. The exterior walls were done with the same feeling of lightness that we have attempted to carry through in the other panel wall buildings that we have done, except that we have used three-inch Mankato stone spandrels, and limestone covering on our columns, and then in turn aluminum sash brought forward more or less flush with the Mankato stone. The glass area is far less than in the previous building, but still adequate to give a very pleasant living atmosphere for the office workers in this building, giving them an opportunity to see the pleasant capitol development around it.

Our picture of the outside dining area of the Stevens T. Mason Building illustrates the living space made available to the occupants of the building. There is a very pleasant restaurant and cafeteria on this ground floor, and an

OUTSIDE DINING AREA OF STEVENS T. MASON BUILDING

STATE CAPITOL DEVELOPMENT

EDWARD J. JEFFRIES HOUSING PROJECT

MICHIGAN BELL TELEPHONE CO. OFFICE BUILDING

outdoor terrace where the employees can dine in the summertime in a very relaxing and comfortable atmosphere.

Smith, Hinchman & Grylls are now in the preliminary design stages of the remainder of the capitol development that is projected at this particular time. The Stevens T. Mason Building is already constructed. In addition to that, there will be a 14-story office building, a Supreme Court and Law Library, and then also a Record or Archives Building.

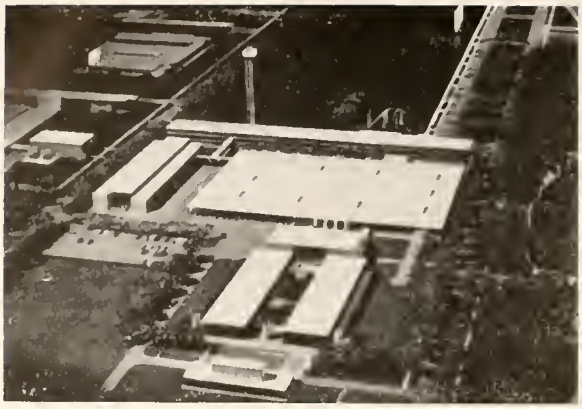
In the design of the general library or Archives Building we are attempting to carry through the same masonry materials, the same feeling that we think is consistent with the stately structures that one would expect to design for a state capitol development.

The main capitol is one of those old relics that most states have, and it was done in a sandstone many years ago. It is just one block away from this group of buildings.

The high rise buildings at the Edward J. Jeffries Housing Project done in brick are not spectacular in appearance, but do provide pleasant, low-cost living facilities for those income groups that need them so badly. Masonry is used because, as has been said many times previously, it is one of the most economical methods of enclosing space.

The 3-story office building and telephone exchange of the Michigan Bell Telephone Company in Birmingham, Michigan, was designed of Norman brick with stack bond, and backed up with eight inches of back-up, two inches

ANGELL HALL, UNIVERSITY OF MICHIGAN



GENERAL MOTORS TECHNICAL CENTER

of tile and ¾-inch plaster, to give a flush interior surface. As you will note, limestone has been used very effectively at the entrance and at one end in the lower story to add color and interest to the building.

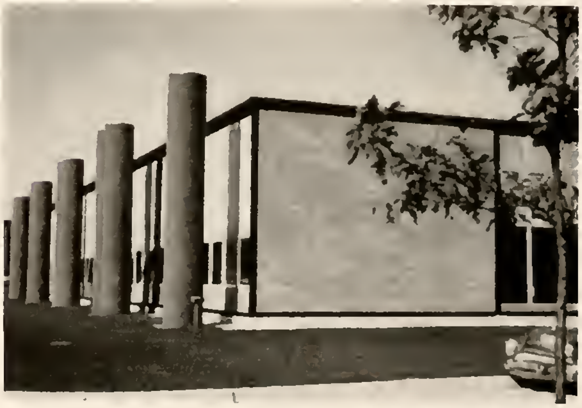
Our 8-story addition to Angell Hall of the University of Michigan is added on to an old landmark. It is a classroom building done in brick laid up in Flemish bond, to match the bond of the original buildings. The columns in the first story and the trim around the window and between the windows is done in limestone.

One of the most publicized projects in recent years has been the General Motors Technical Center, designed by Eero Saarinen and Associates, and Smith, Hinchman & Grylls. Although these buildings are often thought of as metal panel structures, a new material was developed for this project, namely, the porcelain enamel or the enamel brickwork, which was designed in order to give a more or less sculptured quality to the buildings that would otherwise be harsh, mechanical, industrial type structures.

In passing, I might comment that I am very glad to see that the brick industry is taking the steps that they are. They didn't have their fine research organization at the time we started this project. And when the designers wanted a brick that was not the same old mechanical, exact dimension type of thing, they had to design one themselves. So they used a Wyandotte brick, and by working with the Cranbrook Academy of Art, proved you could take a Wyandotte brick and put on a glaze and develop a very pleasant sculptural quality to the material that could add softness to structures such as these.

Briefly, the project includes the research group that you see here, consisting of a dynamometer type building, a shop, a large laboratory, and a metallurgical laboratory. And then at the far end there is the General Motors styling section, and then the engineering development group, and their process developing group, and their service group. All of the buildings have the same general character, but are quite different in detail.

As you drive around the twenty-two acre lake which was created as a focal point for the Technical Center, you will see the very colorful yellows and reds and blues and tangerines and chartreuse bricks at the ends of these structures.



GM TECHNICAL CENTER DYNAMOMETER BUILDING

Above is one of the dynamometer buildings at the General Motors Technical Center, one of the earlier buildings that were developed. There is glazed brick at the end of this structure, and porcelain enamel panels on the side, with painted steel stacks and painted aluminum trim.

We could write a book on all of the things

GENERAL MOTORS TECHNICAL CENTER,
GENERAL VIEW

that we learned about the General Motors Technical Center. Our clients were wonderful in working with us in these new materials. We now know how to make brick such as these. We did not initially. We now know how to make panels. We certainly did not initially. In this particular building, the wall panels have all had to be removed and new panels replaced. We learned, much to our disappointment, that Calo was certainly not a material to put in a metal panel. It went all to pot—but we have solved that.

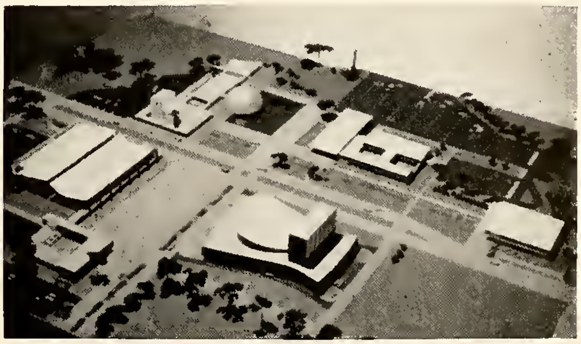
We also learned that there is no such thing as the right kind of glazing compound. In order to lick that problem, we went to the automotive people, and very logically they said "Well, use the rubber glazing that we use on our automobiles." So in the later buildings we set our panels and we set our glass in extrusion rubber, which has eliminated 99 percent of our difficulties.

As one wanders around the General Motors Technical Center, one sees such pleasant views as that shown at the left with the pedestrian light in the foreground and brilliantly-colored glazed brick, which is lighted in the evening and on special occasions in order to give color and texture to the buildings around the main lake. In addition there are the shop-type structures in the background, all softened by the skillful landscaping conceived by Tom Church and a local landscape architect, Ed Eichstedt.

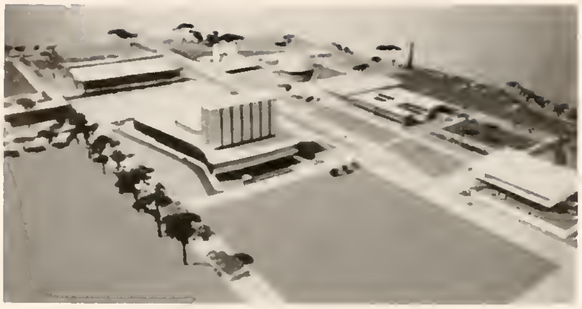
Our black-and-white reproduction of close-up detail of some of the glazed brick developed at the Center misses a most important element

GENERAL MOTORS TECHNICAL CENTER
GLAZED BRICK PANELS

—color. But the picture does illustrate the difference in dimension, the sculptural quality and the irregularity of the brick—the type of thing we were trying to get to contrast with the harsh, mechanical panel and glass exterior.



FLINT CULTURAL CENTER



FLINT CULTURAL CENTER

FLINT CULTURAL CENTER

The Flint Cultural Center, which is being designed by Smith, Hinchman & Grylls, is an example of the use of aluminum panels, porcelain enamel panels, brick, some marble, and all those colorful materials in order to give a vibrant campus atmosphere to the entire project.

This group of buildings will include a large auditorium for approximately 3,000 people, a transportation building, a museum, planetarium, a small auditorium, an art school and auditorium, and a library. It is placed adjacent to a junior college, down the ravine some thirty feet. It is a very spectacular sight up high on the hill with thirty-two acres, which permits the designers to place their buildings in an arrangement that can be very impressive.

Smith, Hinchman feels that a great deal has been learned during the last ten years in the use of metal panel construction. We do not feel, however, that panel construction should be limited to aluminum, stainless steel, porcelain enamel and like panels. There are many instances where masonry units provide far superior materials for specific applications. This is why masonry was used in the Federal Reserve Bank building in Detroit and the Michigan State Capital development at Lansing.

We feel that this is a most exciting day for architectural designers. New materials and techniques have given these designers undreamed of opportunities. In the last few years, however, I'm afraid that too many of us have been so wrapped up in the techniques of constructing miles and miles of prefabricated metal walls which all look alike that we have neglected the warm, colorful, sculptural qualities necessary in good achitecture. Masonry materials can be used to supply these necessary ingredients and should be used wherever possible.

Hospitals

Vincent G. Kling

Architect,
Philadelphia, Pa.

MR. TAYLOR: *If the ex-professor may be permitted one comment, we have been saying for the last twenty years that this new crudity represented by the archaic character of some of the contemporaries would have to be humanized, and I think you see it is being done, and done very successfully, in a very interesting way.*

Our next speaker is a practicing architect from Philadelphia. He has had his professional training at Columbia University. Also, one of his hospitals placed in the AIA Honor Awards. He has combined the functionalism of the complicated problem of a modern hospital with some very striking design. I am very glad to present Mr. Vincent G. Kling.

GENTLEMEN, I am delighted to be here this morning and discuss the hospital problem, with particular reference to masonry.

I hope to give you my basic thesis in a nutshell so I might be able to give you a message that I feel very sincerely is an important one if we are to use masonry properly and effectively in not only hospital buildings, but in all of our design.

I feel the greatest problem we have in applying masonry is to recognize that we have come of age in structures where our buildings are being framed in the lightest possible manner and then being clad in the lightest possible enclosure, compatible, of course, with fireproofing problems and good weathering.

We have done many, many buildings in which masonry products have been the basic

inclosure and a good percentage of the interior subdivision of the building. But we have always tried to use the masonry in a light and skin-like manner.

Masonry, to my father, meant a wall that carried a load; it meant a wall that did a tremendous amount of work structurally. Masonry, to us today, means a system of enclosing space, and certainly a very economical one.

I feel that in adapting masonry units to our buildings we have blazed some trails and made some mistakes. And I am going to bare my soul, just as the previous speaker did, and try to tell you some of the experiences we have had, some of the things we are doing to overcome difficulties we have found.

Now, I guess most of you architects have tried cavity walls on your buildings. It does give us a system of lighter construction. It also gives us a much thinner wall to do the job of keeping out the weather, and also giving us an inside finish. We had some very interesting experiences with cavity walls, and I think probably the most serious one is the come-and-go problem.

When the old masonry walls did a job from the ground to the roof and were bonded through in a very thick and massive manner, they took their thermal stresses in a very orderly way. We find now that cavity walls give a great deal of difficulty in connection with the movement of the outside which takes all the heat and the inside which rocks along behind the air space and doesn't move as much as the outside, and we have some very serious problems with separation of the masonry units. The answer obviously is a much smaller increment of subdivision of the outside skin-facing of the brick.

We have also had some fun with the application of masonry products on the interior. Naturally, when we use them in subdividing space, they become a light division element. The faster they can be put in place, the better. The greener the wall that we can deliver to the customer, the happier he is, because he can occupy the building that much sooner. But that is where we begin to have our problems.

Not so many years ago we started to use thin setting bed materials for applying masonry products. And now I am considering ceramics, structural tile, as part of this family. It makes a very delightful and simple way of facing a rough block wall, simply to apply a glazed tile set with one of the patented compounds that holds that tile to the wall, in lieu of the good old mortar setting method. Two great big problems came into our shop through that installation—the first of which was that the vapor pressure in that wall, the moisture that was entrained in it, particularly if it were a cinder block wall as a divider, wanted out, and it wanted out as soon as the building took heat, and it did a great deal of compromising as far as the adhesive was concerned. So we had this beautiful tile work peeled from our wall.

We also found that the same thing happened in connection with any mechanical gear travelling in the space. If the walls were superheated, the adhesive failed.

The great virtue, it seems to me, in the use of masonry units as an interior space divider in the hospital field is the fact that it has mass, and by having mass, it gives us the kind of acoustical control that we are seeking in so many areas in the hospital. The divider walls between bedrooms, the enclosing walls around labor rooms—the entire objective of building hospitals which have an environment which is conducive to handling people who are in distress. We find that the mass in the wall, when done with a masonry unit, gives us an acoustical advantage over the lightweight construction.

Of course, again, we load up our structure. But I think the very basic law of physics which says that mass stops sound is one which we

POTTSTOWN HOSPITAL, POTTSTOWN, PA. The design combines masonry with panels. The porcelain and enamel egg-crate help to break up the west sun. The end wall and some of the ground level face work are done in brick to tie the new wing in with the old brick structure on the site.

have adopted and we are using very successfully.

I would like to point out that the great objective I have had in the design of this particular building type is to create an environment where people can go when they are sick, when their kinfolk are in distress, and get some lift from the experience of using the building that overcomes the stresses that exist within the walls of every hospital. It is not only good for the people who go there as patients and visitors, but it is very helpful to the people who work in a hospital to enjoy an environment which is quite different from the institutional hospital building that we saw spring up all over the country before the war.

It seems to me that the general practice then was to enclose these buildings with brick or limestone and then subdivide them with a glazed product of some kind in order to get the sanitation and ease of maintenance that hospitals must have.

Now, we cannot quite agree with that today. We think that there must be a little more love and a little more cheer in the thing, and we have limited our glazed ceramic products, structural block, our tile, various types of flooring which give us excellent housekeeping, but very noisy, shiny surfaces—we have limited those to the areas where clinical con-

HUNTERDON MEDICAL CENTER, FLEMINGTON, N. J. This is a brick building with spandrels subdivided at intervals. The brick is complemented with projecting eyebrows in architectural concrete and a textured bottom.

ditions must prevail. I see no excuse for lining the walls, the corridor walls, in a patients' area, with ceramic product that shines with every light that reflects from it and bounces back every noise that is emitted in that corridor.

We do feel there is no substitute, gentlemen, for a good grade of ceramic tile in an area which is subjected to the chemistry, the abuse, the live steam, that a hospital operating room must endure. We have tried other materials. Some of them are excellent under abrasion and excellent under washing operations and have fewer joints. But they succumb to the heat problem, or they succumb to the chemistry problem. And we feel in those areas where the most critical conditions of sanitation must be maintained, the good old ceramic product is pretty hard to beat.

Now, we translate that down to the floor level of the building, and we have a very critical problem in the hospital field today. I guess every agency involved in the safety of the patient in the operating room in a hospital has delved into the problem of floor surfacing for the operating suite, the delivery suite, the emergency operating areas. Modern medicine employs very hazardous gases for anesthetic purposes. These gases, when mixed with oxygen normally administered to a patient on an operating table, produce a very violent explosion when ignited by either static electricity or other electrical disorders in the space.

The National Board of Fire Underwriters says we have got to produce a static-arresting floor in these operating rooms, and they have set a limitation on the ohms of resistance that the floor must have. And until very recently the bible said use carbon black in a terrazzo compound. I don't think that is the answer. We have had too much of it fail. And we now lean back towards the brick and tile industry for the answer that was found in the use of a ceramic tile on the floor.

So we have been working with the tile boys

JEFFERSON MEDICAL COLLEGE HOSPITAL. This building represents the constant striving of the architect to get a building which embraces masonry, but at the same time expresses the light, frame-like quality of our modern structures.

HUNTERDON MEDICAL CENTER, FLEMINGTON, N. J. The sand brick and yellow panels give a warm, cheerful appearance to this TB hospital for children. Hard-burned brick was used for the inside division of the space.

on the subject of tile floors in which each tessera of tile has its conductive capacity built into it when it is fired. We think this is a great stride in this field of safe practice in hospital operating rooms.

Certainly the problems of maintenance and housekeeping in other areas of the hospital are very comfortably handled with tile products—the kitchens, the utility rooms, bed pan closet rooms. I certainly think the toilet rooms do enjoy a very definite advantage from the use of the tile product. We have tried many of the plastic products which have been developed to replace tile, and without belaboring the situation, we still feel that for the very difficult problem of thermal change, a certain amount of chemistry, abusive abrasives and clean-down, your glazed biscuit is about the best answer to the problem.

I would like to talk in a very general way about large sheet masonry materials that we are using—the marble, the limestone, and granite. I think we have built into some of our buildings long-term maintenance headaches by skinning down the physical dimensions of the sheet materials to reduce the deadload on the lightweight steel or concrete frame building. I have concluded that this is a wallpaper operation and we had better stop doing it, because the long-term performance of a

thin facing material is a very hazardous thing for us to recommend in the building of our buildings.

I am sure on some of your jobs the amount of breakage and the distress you have had in setting up thin facing materials could very well have been offset by paying the freight for a little thicker material and doing it right in the first place.

I have therefore designed my buildings with a view toward using masonry in small panel units as a skin material.

Schools

Lawrence B. Perkins

Perkins & Will,
Chicago, Ill.

MR. TAYLOR: *Our next speaker represents the second generation in the practice of architecture. His father was one of the eminent architects of Chicago in the preceding generation. He has inherited a lot of experience in school buildings. His firm, in association with the elder Saarinen, did a building which is not very old, but which is already historic. The school in Winnetka, I think most people would agree, marks the major turning point in the design of school buildings.*

Mr. Perkins is a Fellow of the American Institute of Architects and had his professional degree from Cornell. I am sure that Lawrence B. Perkins will have interesting things to say about school buildings.

EVERYTHING of a general nature which I would like to have said has been said by the preceding speakers in a way that I wish I could have said it. Put me down for several brief "me-too's"—to you, Mr. Kling, on the bitter experience with concrete as a finish material; to you, Mr. Anshen, for many of the things you said beautifully, articulately, wisely, on the relation of materials to each other and your wishes for greater wisdom in their use; and to you, Mr. Hastings, for the many things you said.

The purpose of showing the classroom picture of the Heathcote School, Scarsdale, N.Y. *(at right)* is to illustrate a relation of masonry to the earth on which it rests. It is an instrument for making a warm and pleasant connection between the earth, and the roof of the enclosure.

A not particularly new discovery has been that walls seem to be attacked from the top. Therefore we use overhangs.

During an early experience as a maintenance man, one of my chores was to replace 600 feet of parapet wall, with three other guys. It took us quite a while. In our office today, anybody who wishes to put a parapet wall into one of our designs may do so—coincident with his resignation.

I don't know whether this school building is properly masonry or not, but the effect of the view shown below could be achieved with any building material. The stone which you see there is decorative stone used as transition from the earth to the building. This stone traveled less than thirty feet to get there. It was part of what we had to blast to shape the floor for a little theater which adjoins.

HEATHCOTE ELEMENTARY SCHOOL, SCARSDALE, N. Y.

HOOVER SCHOOL, NEENAH, WISC.

There are two kinds of space. There are the square feet that you build, which you measure, which you pay money for, generally too much money for too few of the square feet. There is also the illusion of space—by far the more important kind of space as far as the art of architecture (as distinguished from the mechanics of building) is concerned.

The illusion of space is what you really experience—relating the inside of a school to the outside to prevent any feeling of being trapped. We think masonry has been an instrument in making possible a feeling of more space than that which you could pay for.

Example—Everybody has ridden in the roomette of a Pullman car. Think for a minute what an intolerable little tin can that would be without its huge oversized window. Suppose you had a porthole instead. Suppose you didn't have the mirrors. Suppose that it actually looked the size that it physically is. How many of you would buy space in it? Not very many. It is tolerable because you sit in a space just barely big enough to hold your physical body, and you find yourself part of the outside world which you are passing. This same attitude is an element in the design of most school buildings today. It is not stylistic reasons or fashion reasons that have caused us to turn our backs on previous structures; it is the need for the sense of flow from the limited space in which you sit to the larger space in which you wish to take part psychologically.

HEATHCOTE SCHOOL, SCARSDALE, N. Y.

I think that structure and materials have had relatively little to do with the change in design of school buildings. The changing awareness of how people use buildings, how they feel about buildings, how teaching is conducted, how learning takes place, these have done more to change the design of schools than all the technology of this century.

There have been some improvements, of course, particularly mechanical. But many schools you see could have been built in 1900.

The need to approach children in many different ways rather than the single-minded, bookish way has necessitated a broadening of the tools of teaching, which in turn requires just plain space.

BLYTHE PARK SCHOOL, RIVERSIDE, ILL.

POCANTICO HILLS CENTRAL SCHOOL, N. Y.

To achieve that space, we have done what was done in the time between the Romanesque churches and the Gothic churches and undone when the Gothic style started to have its reciprocal influence back on its parent, Italy. We have taken load-bearing walls and used them where they are normal to the exterior of the building rather than to enclose space. This change of thinking, from the enclosed space to the larger, open, and more fluid appearing space, is, I believe, a response to people rather than structure.

The quite comfortable suburb of Winnetka, Ill., chose to let this building shown below go ahead in the common brick with which we normally face the back and sides of a cheap apartment building. This is a select version of our Chicago common. This overhang takes cognizance, in a structural sense, of the fact that in every building, the minute the second brick gets on the first, the forces of nature begin their work to put that building back into the earth again. Think how sad you would be if it were not so and we had all of the inheritance of buildings that were built thousands of years ago. Destruction is a very merciful thing. I have had many occasions to give thanks to it in other people's work, and sometimes in our own.

Choosing this common brick for what was then the luxury public school building of the country—1939—was, I think, more than a piece of calculated arrogance. It certainly was designed consciously to shame the prudes who put face brick on the front and this on the side and back. I believe there is a song about the Queen Anne in front and Mary Anne behind. We decided here that perhaps it would be an interesting contribution if we could glamorize Mary Anne.

CROW ISLAND SCHOOL, WINNETKA, ILL.

Closing Remarks

C. E. Silling

C. E. Silling & Associates, Charleston, W. Va.

We are indebted to the Chamber of Commerce for this handsome mounting for the program of the Building Research Institute, and it is a privilege for the Institute to have the use of these accommodations.

I cannot resist saying, on behalf of the architects included in the several technical panels of this conference, that I would like to thank the Building Research Institute for them, for the privilege they have enjoyed in meeting with you and participating in your studies.

I think architects are stimulating and interesting people. It is conceivable that, in certain personal instances, some of you may prefer a more colloquial description of architects.

In this Building Research Institute Conference on Modern Masonry, you have heard authoritative statements on research in fire clay products, natural stone, marble, granite, the cavity, veneer and face-bonded walls, methods for their reinforcement, their thermal performance, in-the-wall costs, and a variety of ideas on maintenance. Also we have had an analysis of building types, the importance of over-all industry adoption of modular measures, so ably presented by Mr. Ralph Walker, the aesthetic demands of contemporary architecture upon masonry.

All of us in the Building Research Institute are indebted to these several speakers for the exhaustive treatment of their subjects and

their generosity in coming here for this occasion.

But that they would do so is full recognition of the eminent place occupied by the Building Research Institute in this great sprawl of American business called the building industry.

Emboldened by the kind tolerance of my impertinent introductions of the session chairmen, I would now like to hazard these personal remarks.

I believe one of the greatest unrealized and unexploited opportunities for the building industry to capture the public imagination and deliver to it a real added value in design and lower cost lies in an industry-wide adoption of the system of modular measure. In my view, once it is adopted and its many advantages properly advertised, our competitive reach for the investors' and the consumers' dollar will be comparably improved. It is not something that is uniquely proposed to be projected whether or not you are willing. It is a world-wide search. You remember that Ralph Walker told you of the studies the British were making. Bill Demarest, who headed this up for the AIA, has appeared by invitation in France to discuss this method of construction. Australia sent a productivity team to this country, and one of their prime interests was a rather exhaustive study of modular measure.

At this meeting, I have been invited to meet at a later time with architects and building people in a Canadian national convention.

So that it is not just something that is picked out of the air, but it has a history and a success where it has been used, in the very simple manner in which it has been set up.

I believe adequate shelter is the business of everybody. When a masonry unit of any material, color, texture or size is manufactured, quarried, processed, sold, or incorporated in any manner in or about a building, every human component that comes in contact with it at any stage of that development exerts his influence for good or evil on the aesthetic and economic effect of contemporary architecture. We plan and design together—manufacturer, supplier, contractor, architect, owner. Let us search ourselves that each one of us may aid in an improving culture for all of our people.

Gentlemen, the Conference on Modern Masonry is adjourned.

Attendance at the Conference

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